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—IN—

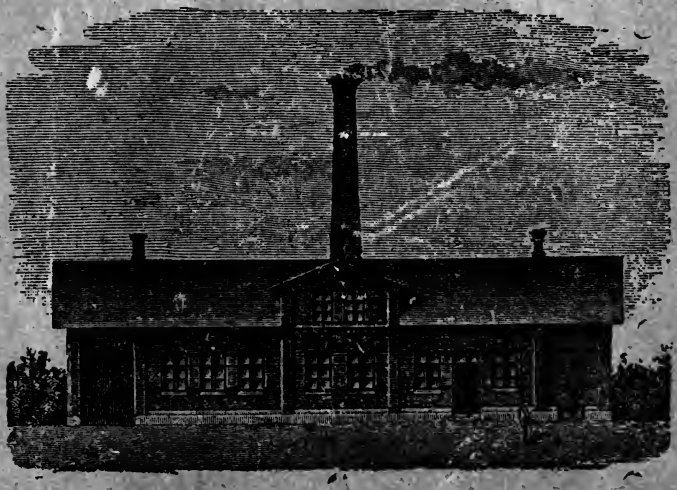
Butter Making

For Young
Creamery Butter Makers
Creamery Managers and
Private Dairymen

—BY—

J. H. MONRAD

Printed by URNER-BARRY CO., 173 Chambers St., New York



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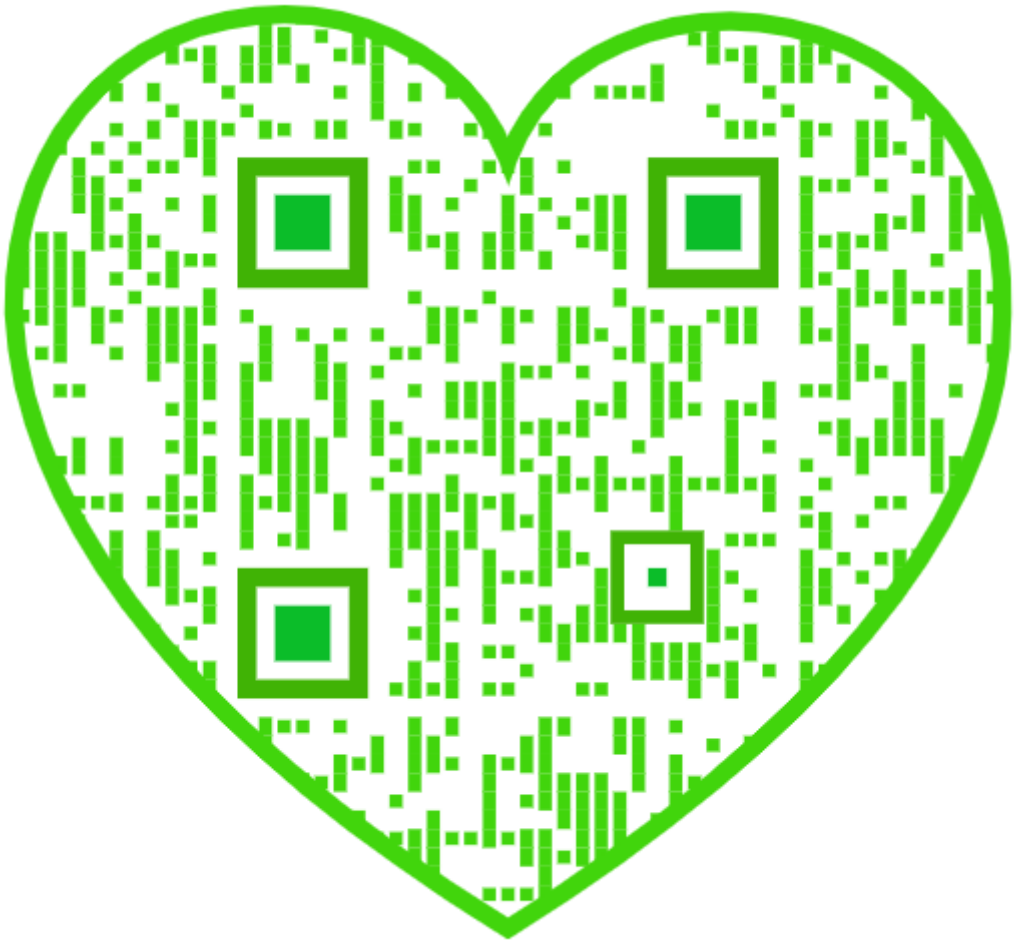

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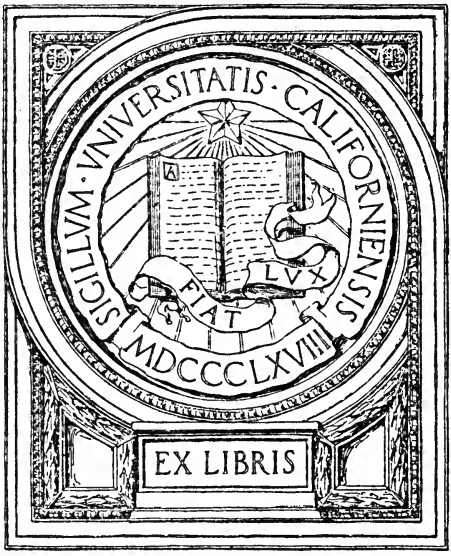

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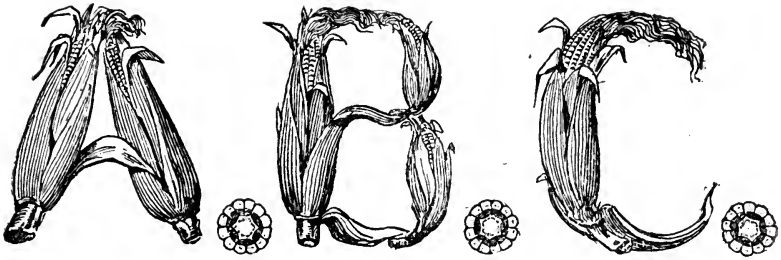

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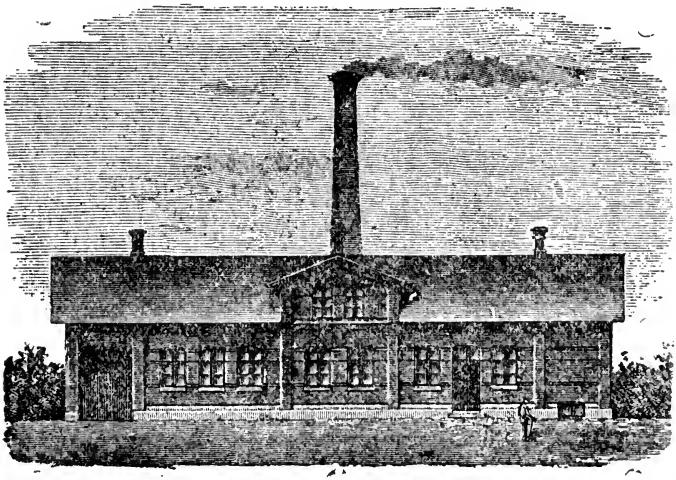

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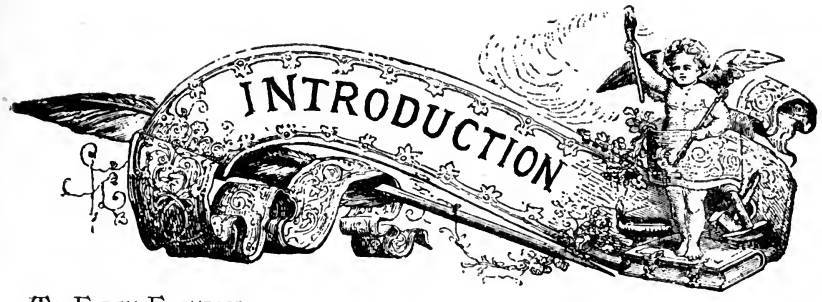

To First Edition.

I do not pretend to fill a "long felt want" by publishing this little book. Indeed, I realize how absurd it is for a man who denounces the so-called "general purpose" cow to the dairymen, to publish a small "general purpose" book.

Nevertheless, I hope many private dairymen as well as creamery men will find pointers in it which will make it worth their while to read it.

If I only succeed in making the reader eager for more information, I shall have accomplished one of my purposes, and the other, to make some money for myself, I trust a quick sale of this edition will realize.

J. H. MONRAD.

September, 1899. Winnetka, Ill.

To Second Edition.

Five years in this age of continuous inventions make it necessary to change and add a good deal to the first edition. Though I have been asked why an illustration of a Danish Creamery was used instead of an American one on the front page, I have retained it in order to induce other States to follow, as Minnesota has, the Danish plan of having good permanent brick buildings with cement or flagstone floor.

J. H. MONRAD,

January, 1905. 173 Chambers St., New York.

To Third Edition.

I find but little to change from the second edition; the greatest progress in the dairy appliances has been in better and more sanitary manufactory. As to the art of buttermilk, there seems to have been a tendency to aim at quantity rather than quality, which I must warn against.

J. H. MONRAD,

January, 1910. Copenhagen, O, Denmark.

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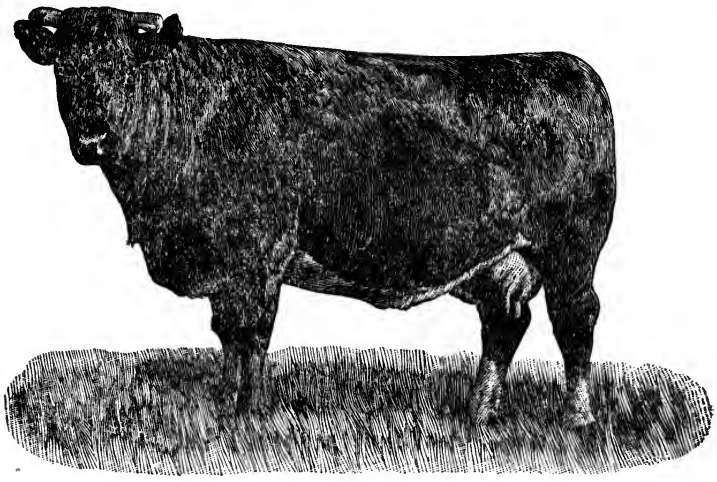
CHAPTER I.

THE MILK PRODUCTION.

WHICH COW DO YOU MILK?

"First, catch your hare," is the instruction given by a certain authority in cooking, and the buttermaker, to make a success of his profession, must first of all see to it that his raw material—milk—is produced as cheaply as possible. This is the duty not only of the farm buttermaker, but of the creamery buttermaker as well. No creamery can succeed in the long run where the patrons



DIDO.

produce milk at a loss; and milk is made at a loss firstly, by milking the wrong cows, secondly, by wrong feeding and care, and, thirdly, by careless, uncleanly handling of the milk.

The question then is *Which cow do you milk?*

Do you milk the blocky, plump *Dido,* who, though she gave 5,562 lbs. of milk, or 216 lbs. of butter, produced the latter at a food cost of 18.2 cents per pound, or do you milk the "spare, angular cow with a deep body," like *Houston,* who produced the butter at a food cost of 10.8 cents per pound?

In this question of Dairy Form (compare illustrations), first raised by W. D. Hoard, lies the main secret of profitable

or unprofitable milk production and, consequently, buttermaking. There is no room in this little treatise to go further into details of the interesting experiments reported by Prof. T. L. Haecker, in Minnesota Experiment Station Bulletin 35, from which the illustrations have been taken.

Some tests have also been made in Denmark, in which the cost of production from 200 cows varied from 15.1 cents to 78.5 cents per pound of butter.

These experiments show that the profitable dairy cow is found not only by selecting a particular breed, but also by paying strict attention to each *individual* cow. The "average" cow is the curse of dairying. It requires no great intelligence to see that it is better to milk six cows giving a good profit than to milk ten,

HOUSTON.

four of which reduce if they do not annihilate the profit of the other six. But this is what is being done on seven or eight farms out of ten.

If it is important to test the individual cows of the dairy breeds, how much more with the so-called general purpose or dual purpose cows. In my opinion it is possible for a breeder of beef cattle to produce a fair lot of milk "on the side" at a profit, but it is folly to attempt producing steers from dairy cows, though possibly baby beef may be made to pay. Yet some splendid milkers may be found among so-called dual purpose cows and if they stand the test, why not use them? It must also be remembered that it takes a *dairyman* to care for a *dairy cow,* and the best cow alive may be unprofitable in the hands of an unskillful, careless man.

TEST ASSOCIATIONS.

If the individual milk producers do not like to take the trouble to test their cows and keep an account with them, ten or twelve may co-operate and hire a young man to do it. Such a Test Association was started in 1895 in Denmark, and in 1908 that country boasted of 479 such. If desired, the selection and buying of pure-bred bulls may also be made the object of such an Association. Co-operation is the only way in which the farmers can hold up their end of the line.

I cannot too strongly urge the formation of these associations, and the State or National government might well encourage them by subsidies, if proper reports are made annually. Little Denmark spends $32,400.00 on subsidies to them.

It is, however, very little work to weigh the milk from each cow once a week and test it with a Babcock Tester. If there is no creamery nearby willing to do it cheaply, a good four or eight, bottle tester can be bought for $8.00 to $10.00. Figure 1 shows one made by the D. H. Burrell Co., and all our leading firms now make good ones.

The spindle legged cheap tester should be avoided. But testing will not be treated here in detail as Professors Farrington and Woll, in their book on "*Milk Testing*" (see list of books) treat the subject in an exhaustive and practical manner, and every dairyman should buy this book as well as a tester.

(Fig. 1)

As to keeping track of the cost of food, there is no need of weighing it out to each cow; but it is enough to make a memorandum now and then and note the dates when changes are made, so as to give a fair idea of what has been consumed during the year.

As a beginning let creamery men and patrons co-operate and keep track of the number of cows *fed* (not milked) by each patron, so as to know the average milk yield on each farm at the end of the year. The difference revealed will be an eye-opener and prove the necessity of testing each individual cow.

WHAT FEED TO USE.

It would be absurd here to attempt to reply to this question, which Prof. W. A. Henry, of Madison, Wis., has treated in his

600-page *"Feeds and Feeding,"* and Prof. Jordan in his 450-page *"Feeding of Animals,"* but it cannot be dodged altogether in discussing the economical production of milk.

All food consists of various elements that are grouped mainly as proteids, muscle producing elements, and carbohydrates, fat and heat producing elements. Various experiments have shown that the best result is obtained when these are present in the food in a certain proportion and that it is partly waste when either is given in too great excess. What this proportion should be, is a mooted question, and the Germans proposed to vary it according to the quantity of milk given. Prof. Woll suggested 24.5 lbs. (dry matter) with a proportion of 1 lb. protein to 6.9 lbs. of carbohydrates. This ratio was based on the actual rations given by 128 successful American dairymen—but it seems to me that the *economical* ratio (proportion) will depend somewhat on circumstances, that is, on the local price of the various feeds. Judgment must be used to decide whether, for instance, to sell oats and corn and buy bran and oil meal or not, and cost of freight and hauling both ways must also be considered.

In our western states the carbohydrates are produced in excess and consequently the mistake of feeding too much of them is often made, as when corn is given in excess. The rations should be balanced up by adding bran, peas, linseed or cotton seed meal, the latter containing over three times as much protein as corn and only half the amount of carbohydrates, but, best of all, alfalfa should be grown, and "if at first you don't succeed, try and try again!"

I can do no better than quote from the Wisconsin bulletin, No. 116, by Prof. F. W. Woll:

"The general trend of the results of feeding experiments with milch cows is in the direction of showing that protein feeds possess a somewhat higher value of milk production than feeding stuffs of a more carbonaceous character, but the profitable extent of feeding such feeds must be determined largely by local conditions. With a fair amount of protein in the ration supplied of farm-grown foods, the narrowing of the ration fed, by the addition of protein foods, is not a matter of prime importance. The testimony furnished by studies of the feeding practices conducted

under a variety of conditions plainly shows that excellent results may be obtained by the use of quite wide ratios; a liberal supply of digestible matter in the rations of cows that are good producers is of importance, irrespective of the proportion of nitrogenous nutrients found therein, if the rations contain a minimum of protein, which may be placed for different cows at from 1.3 to 1.5 lbs. At the same time it should be borne in mind that the cows are most likely to produce milk of the best quality of which they are capable, on rations that contain a fair amount of protein, and have nutritive ratios not wider than about 1.7, for cows in full flow of milk; under ordinary conditions in the north central states a somewhat narrower nutritive ratio than this will, generally speaking, prove profitable, where the permanent effect on the production of the herd is kept in view."

It is with great satisfaction that I note how the scientists are nearing the view of practical feeders.

It behooves every dairyman to take stock of his available feedstuffs and inform himself as to the cost of various commercial feeds and then calculate the most economical ration for his cows, under his conditions.

Until the younger generation of farmers is educated up to the necessary calculations, it is a simple matter to write to your Experiment Station and state what feed stuffs you have and their selling value as well as local prices of bran, oilmeal, etc., and ask for suggestions as to proper rations. Or, if you are—as you ought to be—a subscriber to *Hoard's Dairyman*—you simply write to that paper.

But, and a very large BUT, we must always bear in mind that chemical analyses of feeds are averages and may not fit your case exactly, and that the practical farmer, while taking hints from the chemist, will feed his cows with one eye on the milk pail and the other on the excrements. Give your cows a variety of sound feed, and if stabled, provide a succulent food, either roots or silage, and remember that where corn will grow *no cheaper food basis exists than well-preserved silage.*

In summer the most common mistake, which increases the cost of production, is to allow the cows to shrink in yield when pastures are getting poor, instead of supplementing them ***at***

once with some sort of a soiling crop. Any dairy farmer deserving the name should have a few acres planted for this purpose. If not needed it is not lost. Silage is also used for helping out pastures by such men as H. B. Gurler. Finally let me put in a word for cutting hay early and curing it as *hay* and not as *straw,* and for the making of *oat-hay.*

These general outlines being observed and the feeding and watering being done at *regular* hours, we have done what is possible to produce cheap milk as far as feeding is concerned.

I mention six daily rations which Prof. Woll recommends as good examples.

1. Corn silage 40 lbs., clover hay 8 lbs., wheat bran 6 lbs. and corn-meal 3 lbs.

2. Corn fodder 20 lbs., hay 6 lbs., oats 4 lbs., shorts 4 lbs., oil-meal 2 lbs.

3. Corn silage 50 lbs., corn stover 6 lbs., oats 6 lbs., malt sprouts 4 lbs., corn-meal 2 lbs.

4. Corn silage 30 lbs., hay 15 lbs., wheat bran 3 lbs., corn-meal 3 lbs., cotton seed meal 2 lbs.

5. Timothy hay 10 lbs., clover hay 8 lbs., wheat bran 6 lbs., oats 6 lbs.

6. Corn fodder 20 lbs., clover hay 8 lbs., oats 6 lbs., oil meal 3 lbs.

INFLUENCE OF FEED ON THE RICHNESS OF MILK.

Most farmers as well as scientists labored for years under the delusion that an increase in the feed, and especially in that rich in fat, would increase the percentage of fat in the milk. Later experiments have proven that this is not true to any extent worth mentioning. Feeding to excess or feeding very rich food may for a short time increase the richness, but it soon drops into the percentage normal for each cow and the ambitious breeder who "tests" his cows that way has a fair chance of ruining them for life.

Why, starving a cow will make her give abnormally rich milk, though less of it.

Increasing the feed of a cow, not fed up to her full capacity, will increase the milk yield—the total amount of butterfat pro-

duced—but not the percentage of fat in the milk. If this old belief were correct, we should be able to make "Holsteins" give "Jersey" milk!

We want to feed all a cow will pay for—no more, no less.

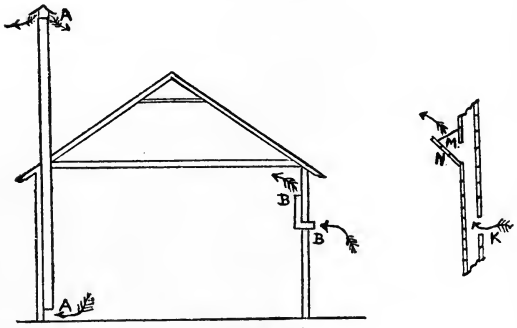
WHAT CARE DO YOU GIVE YOUR COWS?

The right cows being secured and the right feed given at regular hours, we may yet lose the advantages gained if the cows are kept shivering in the lea of a strawstack or suffocated in a dark, close stable.

If she is left to shiver in fall rains and snow, the cow will not only utilize a large amount of her feed as a fuel to keep warm, (an expensive firewood, indeed), but as experiments in Denmark have shown, she will change the composition of the butterfat in her milk so much that the butter is liable to be mistaken for oleomargarine! I have no doubt this is the real cause of that lack of flavor every fall, for which our butter merchants blame the "frozen grass."

There is no need of providing fancy stables. We may even make fairly good ones with a clay floor and the walls and roof of straw, if we only provide ventilation and light. The latter calls for the heaviest cash outlay, but sashes are now so cheap and the value of light of so great importance to the health of the cows that there is no excuse for not having plenty of it.

As to ventilation, I give in Fig. 2 a cross section of a stable 14 feet by 8 feet high. A wooden flue (A A) is placed along one wall and made high enough to give some draft or at least four feet above the ridge of the roof.



(Fig. 2)

On the opposite wall are inserted two or three flues like B B, or, if the wall is a double boarded one, the air may be taken in by leaving a board out between two studs on the outside at K (on the piece of wall shown) and another one on the inside at M, but in that

case a board N should be nailed in a slanting position with end pieces on either side so as to give the air a slant in direction of the ceiling.

As to the size of the flues, Prof. King, of Madison, Wis., (whose excellent book, *"Physics of Agriculture,"* every farmer ought to have) considers that for 20 cows they should have a cross-section 2 feet by 2 feet. The intake of fresh air need not be nearly so large, as there are always leaks at windows and doors and it is better to have several small intakes to prevent draught. This principle—air circulation without draught on the cows—can be applied to a straw stable as well as to the most expensive one.

Comfort is an important element in cheap milk production, and while fixed stanchions may make it easier to keep the cows clean, we need only observe them when lying in the pasture to know how cruel and unnatural their position must be in those "animal stocks." Somewhat better are the various swinging stanchions, but tying them, or—if it can be afforded—one of the modern stalls like the "Bidwell" or the "Drown" are the only right systems, and a liberal supply of bedding will not only help to keep them clean and make them comfortable, but increase the manure heap, which the Danish farmers call their "gold mine."

To keep a cow tied up all winter is in no way a natural treatment, and though it is done by many good dairymen (thus universally in Holland and Denmark), the trend is now, as Mr. H. B. Gurler recommends in his *"American Dairying,"* to give them lukewarm water outside, and if the weather is fairly mild let them remain there an hour or two at their option. This advice should not be misunderstood as a defense for those farmers who turn their cows out to drink through a hole in the ice on the watering trough.

The more the cow is deprived of exercise, the greater the need of keeping the pores of the skin open by daily carding and brushing. Indeed, this is not only a question of health (cheap milk production), but also of cleanliness (pure milk). It is a wonder to me that the farmer who will give his time willingly to keep his horse clean, begrudges it to his cows. It is a question of health in both cases, but in the latter it is also a question of health to his

own family and those who may drink the milk, not to speak of the quality of the butter. Either on the farm or in the creamery, cleanliness means dollars and cents.

MILKING.

The manner in which the milking is done has also an influence on the cost of production. *Regular hours* are all-important and so is kindness. Indeed, I do not believe any one quite a success as a milker unless he (or she) can make the cow look upon him (or her) as an adopted calf.

The importance of milking the very last drop is due not only to the fact that the last pint is many times more valuable (richer in butterfat) than the first, but also to the fact that it helps to keep up the flow of milk and extend the milking period. This is especially important in developing heifers. The money lost all over the United States by poor milking can hardly be overestimated.

Cleanliness in milking means quality in the butter. If the cows are cleaned and brushed an hour or so before milking, so as to let the dust settle, the only precaution needed is dampening the udder with a wet cloth so as to prevent scales and dust from falling into the pail. Many milkers have the bad habit to let their fingers get wet, sometimes deliberately dipping them into the milk, so as to make them slide down the teats. The proper way is to milk with perfectly dry hands, by squeezing, not by sliding. Only in "stripping" to start the flow and to get the last drops of milk, it may be preferable to slide the fingers down the teats.

It is hardly necessary to say that hands and fingernails must be clean and that all utensils must first be rinsed with cold water and then carefully washed and scrubbed—using soda, the excellent "Wyandotte Cleaner and Cleanser," "Savogran," or "Gold Dust" (never common soap) when needed—and finally rinsed with boiling (not 190 or 200, but 212 deg. Fah.) water. The pails and cans should be easy to clean and the seams soldered perfectly smooth as any little unevenness in the surface makes them more difficult to clean.

These rules for producing clean milk are not new; over a hundred years ago they were observed by the good buttermakers, but it remained for the last decade of last century to explain the reason "why," and thus make the tedious work easy.

Souring of milk, and indeed most of the taints from which milk may suffer, have been shown by our scientists to be due to various bacteria. These bacteria thrive in the excrements and dirt; and they float on the dust and drop into the pail while milking; they abound in the little specks of dried milk left in the crevices in badly soldered cans, in poorly cleaned strainers, in rags used for wiping the cans after washing (which should never be done), in dust gathered on the cow's hide, under the fingernails of the man who milks, in fact everywhere.

When we know this, we understand the necessity of the precautions hinted at, and when we know that these bacteria will multiply in the warm milk much more rapidly than in cold, we understand the value of cooling the milk or cream as much as possible *at once* in order to deliver it in the best condition to the creamery.

Every bacterium which is in the milk as it leaves the stables will multiply 23 times in two hours at 95 deg., 215 times in four hours and 3,800 times in six hours. But if the milk is cooled to 55 deg. they will multiply 4 times in two hours, 8 times in four hours and 435 times in six hours, *while if the milk is chilled in ice they will hardly increase at all.*

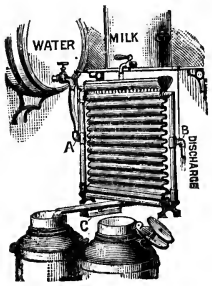
BETTER CARE NEEDED FOR MILK AND CREAM.

It is not so hard to convince the private dairyman of the need of all these precautions, he will at once see their value in a better product—better price. But the farmer should also be willing to acknowledge their need when sending the milk or cream to be made into butter at the creamery. He is just as much interested in the final result whether the creamery be run on a strictly co-operative basis or by an individual. Indeed, as the milk has to be transported before being separated and the bacteria get a better chance to develop than if the butter is made on the farm, handling the milk for the creamery requires more care. If patrons understand this and act accordingly, it will be easy to increase the value of our creamery butter from 1 to 2 cents a pound, or, for the United States, say from three to six million dollars.

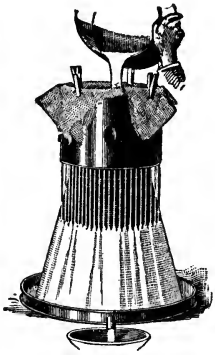
COOLING AND AERATING.

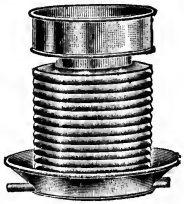
Experience has shown that the very best way of preparing milk for hauling is to run it over one of the combined aerators and

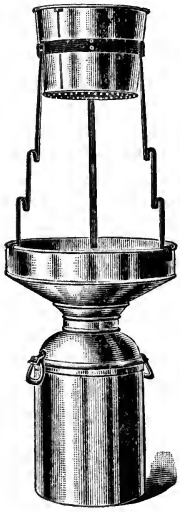
coolers. The three best styles are represented by Fig. 3, the "Star Cooler," by Fig. 4, the "Champion Cooler," and Fig. 5, the Schmith System. The first and the third are arranged so as to have water, or, better still, iced water, flowing in the opposite direction from the milk and will cool the milk in the most economical manner. Other manufacturers, such as A. H. Reid Creamery and Dairy Supply Co., Vt. Farm Machine Co., Creamery Package Mfg. Co., etc., make similar coolers. The second is preferable where water is scarce and ice is available.



(Fig. 3)


(Fig. 4)

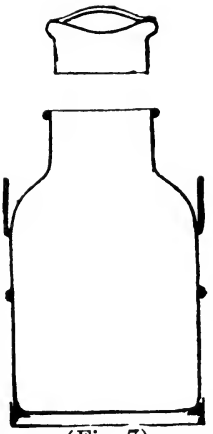

(Fig. 5)


(Fig. 6)

The compromise of aeration without cooling more than the temperature of the air will allow, will be far better than straining directly into the shipping can, and for this purpose the simple apparatus shown in Fig. 6 is satisfactory. It consists simply of a pail with perforated bottom into which the milk is strained and from there drops into the receiving funnel. It is made by D. H. Burrell & Co., Little Falls, N. Y.

Setting the can in cold water and aerating by dipping is, *if conscientiously done,* a great help, but the way it is usually done it is a delusion and a snare. *Nor must it be forgotten that aeration in anything but absolutely pure air is bound to prove detrimental instead of beneficial.*

A NEW MILK CAN.


(Fig. 7)

Attention has been drawn to the importance, in buying cans and pails, of seeing that the soldering is smooth and even, but even if it is, the seams remain the danger point. In Fig. 7, I illustrate a Danish improvement. The cans are made of two pieces, pressed out of the very best English steel plate, joined in the middle of the side and heavily tinned. The cover is of one piece and the handles only are riveted. Prof. Boeggild strongly recommended this can in *"Maelkeritidende,"* and it has given good satisfaction in the past six years. The price for the 8-gallon size is $3.00 in Denmark, but if it is durable it would be cheap at $5.00. Now they even make 10-gallon cans stamped out of *one* piece of steel. These cans are now made with an anti-rust composition imbedded in the bottom, claimed to be innocuous.

STRAINING.

The strainers on the market are innumerable, but most of them are delusions and snares. "Prevention is far better than cure." In the first place all the fine metal strainers only keep the coarse dirt and chaff out, moreover nearly all of them allow the milk to rinse the spores and bacteria off the dirt as it lies caught in the meshes. Fine muslin is better, and light flannel is the best, as long as it is kept clean, and renewed when felted, so as not to delay the work too much. I am not in favor of the so-called sanitary milk pail, with a small opening in the top to admit a strainer, in which the milking is done, the difficulty in keeping it clean counterbalances, in my opinion, the advantage, unless the opening is in a loose cover.

Far better will it be to cover the pail with a piece of light flannel or double muslin, allowing it to sag in the middle; four clothes pins will keep it in place. For straining into the shipping can or separator tank, I also prefer the strainers that are easy to clean, having no nooks and corners.

KEEPING ACCOUNT.

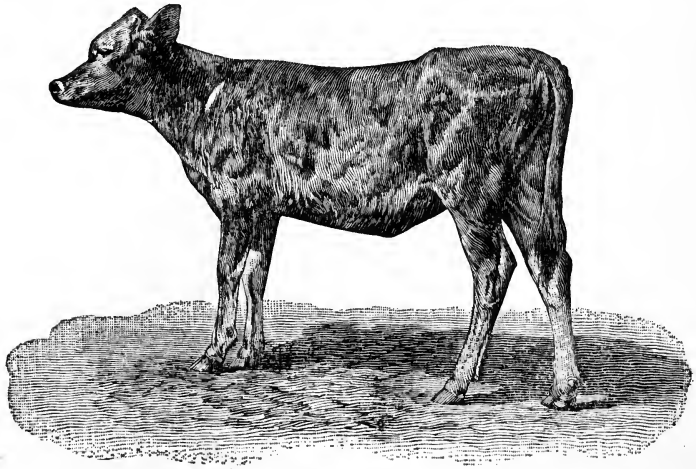
I simply suggest the following ruling for the record of the individual cows. It requires two pages with 26 lines for each cow. In the column "For Week," you insert the "Total" daily

milk yield multiplied by seven, and in that of "Pounds Butter Fat" the result multiplied by the percentage of fat and divided by 100. To calculate butter yield add one-sixth to the butter fat.

Weekly Record of Cow No..... Born..... The calf dropped ..... Served..... Due.....

Date of Test	MILK IN POUNDS				Babcock Test	Pounds Butter Fat	Remarks
	Morning	Evening	Total	For Week			

In testing cows they should be milked at exactly the same hour in the evening on the test day as on the day before. The total milk should be weighed or measured daily in order to control the production, and so should that used in the house or for the calves. The last pointer I desire to give in this chapter is to suggest either the offering of premiums, as Mr. Gurler does, to those milkers (be they hired men or your own boys and girls) whose cows keep up the milk flow best, or making them co-partners by giving them a certain share in whatever the cows yield during the year over a certain amount. If you do this and let the milking be counted as *work* and not as a little extra "chore" to be done after dark (sooner or later, as the field work may allow), you will find the cows will respond and the *cost of production will be reduced.*



PROF. HAECKER'S IDEAL CALF, "YOUNG HOUSTON."

CHAPTER II.

RECEIVING MILK AT THE CREAMERY.

THE GREATEST TRIAL.

The greatest trials of a creamery buttermaker are at the weigh can. It is there he must show his knowledge of human nature, his diplomacy and his sense of justice. We will presume that the proprietors (individual or co-operative) have given him the strong moral backing of a well-built, neatly painted creamery with neat surroundings, as well as full authority to reject poor milk. We will also presume that he has recognized the same principle by keeping the platform, the scales, the wall and his person perfectly neat and clean. (This presupposes also that he is not expected to be on a jump between the boiler and the receiving can).

All this given, he has yet to show his diplomacy by treating the various patrons in a way to suit their individual idiosyncracies, so as to obtain the desired result—pure, clean milk. He has yet to show his backbone and sense of justice by refusing to accept tainted milk, which he knows will deteriorate the quality of butter even if it belongs to the owner or one of the directors. He has yet to learn that the patron's interests are identical with his own. Every patron delivering milk should back up such a milk receiver, he is fighting in their interest, as they would lose by the acceptance of the tainted milk.

TESTING MILK.

To run a creamery on the pooling system is so absurd that it requires no mention. I am in reality in favor of having an outsider—at best—a woman, receive, and take the samples and test the milk, but in any case the testing should be done openly and fairly to all and no one should do this work who has not studied Milk Testing carefully. Suffice it here to say that the better the milk has been cared for, the easier it is to secure a uniform, fair sample. No maker can afford to juggle with the test scale either

to favor certain patrons or to make a showing of paying more for butterfat than does a neighboring creamery by reading the test low or giving short weight. In the first case he steals from some patrons in favor of others; in the second case, he is simply helping his employers or his patrons to fool themselves and others.

In testing it must be remembered that the taking of a correct sample is the most important part of the work and that when milk is left at rest only for a few minutes, the cream will commence to rise and it will make a difference whether the sample is taken from the top, the bottom or the center.

With small lots, as for instance in sampling single cow's milk, it is easy enough to get a fair sample by pouring the milk from one bucket to another a few times, but this must not be done so violently as to make it foam too much. If close work is desired for composite samples (the collecting of two or more samples for testing at once) the "Scovell" tube is safest to use. By this, if the sample is taken from a cylindrical vessel, a proportionate amount is secured each time. Thus, if a cow should give 30 lbs. of 3 per cent. milk in one milking, and 15 lbs. of 5 per cent. milk in the next (to quote an exaggerated example) the result would be exactly correct; whereas if we took equal samples, the result would be too high.

But the difficulty in getting a good sample is greatly increased when we come to large quantities of milk as delivered at the creameries. It is true that, if the milk is delivered every day, and has been stirred while cooling, the pouring into the weigh can and a few vigorous strokes with a long-handled dipper will enable us to get a fair sample. Yet patrons don't seem to realize the advantage of taking good care of the milk and the result is that cream clots will float on top; in taking the sample, these must be avoided and the farmer gets a lower test.

The Scovell tube is ½ to 1 inch in diameter, with three openings and has a cap at the bottom. The tube is pushed gently to the bottom of the can and pressed so as to push the cap above the openings securing a column of milk exactly like that in the can.

For creamery work the objection is that too large a sample is secured and also that in doing the work—as must be—in a hurry, milk is apt to adhere to the outside and if there is any cream on

top this will naturally hang on and part of it get mixed with the sample. Of course this can be avoided by holding a cloth round the tube in one hand while pulling it out with the other. Of other samplers I mention the Kolarik and Werder's, and Prof. McKay's.

Another system has been used, namely, to have a very fine hole or drip-cock in the conductor from the weigh can to the receiving vat to catch the drip. Experiments at Wisconsin Dairy School have shown this method to be very exact.

THE FERMENTATION TEST.

The test for fat, is, however, simply a question of a little care and absolute honesty, while the test for taint is far more difficult.

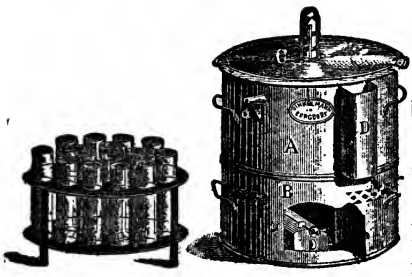
When milk arrives at a temperature between 70 and 90 degrees and the receiver's nose is in good working order, it is comparatively easy to discover taint, but when the milk arrives ice cold it has to be badly tainted to be detected at once.

The receiver should take the cover off the cans personally so as to get the very first whiff. He should first see that the outside of the can is clean and when pouring the milk into the weigh can he should watch the bottom and the seams of the can. The patron should not get huffy, but rather be pleased when he sees such a close examination.

The truth is that the patron—if he does his duty—is more likely to know when the milk is bad and should draw the receiver's attention to it, instead of being "tickled" if he succeeds in getting a bad lot of milk passed into the receiving vat.

Even with the greatest care, tainted milk will be taken in and the only way to locate the trouble is to use the *Fermentation Test.* When it is located, visit the farm, and if the combined efforts of farmer and buttermaker cannot discover the cause, then the same test should be applied to each cow.

This test is simply to sterilize (by boiling) some glass tubes 5x1 inch (or else the "common sense" half pint bottles) and take a sample of milk in each. Keep these covered at a temperature from 90 to 110 degrees, by keeping in warm water. After five or six hours observe them, without shaking, every hour or so, note the time of coagulation and, after 9 to 12 hours, see how the



(Fig. 8)

curd acts. If it remains one solid column like pure marble and, on being shaken up, has a pleasant, clean acid smell and taste, the milk is first-class. If, on the other hand, the curd has a large number of more or less irregular holes, it will, as a rule, when shaken, have a stench which will convince the most skeptical patron. In Fig. 8 I illustrate the original "Gerber" test, in which a lamp heats the water bath.

This test will also help the private dairyman in trouble and indeed it is the duty of every farmer who receives a complaint from the creamery to attempt to find the cause, and, in the last instance, make this test.

I should not be afraid of guaranteeing my butter at a creamery if the farmers kept a sample of their milk under this test and only sent me such as their wives were willing to drink at the end of the test.

As to acidity, I am not so afraid of that, as long as the separator does not get clogged, and, unless I wanted to pasteurize it, the nose and tongue is guide enough without the aid of the Acid Test. But, if we want to pasteurize or perchance ship the milk to a city, then the acid test is of great value.

It remains now only to refer to the "Alcohol Test," which is too expensive to use in the States and the latest "Reduction Test" which seems promising especially in connection with the Fermentation Test as suggested by Prof. Orla Jensen.

At the weigh can is the weak point of co-operative dairying, be the factory run by an individual or by the farmers, and not until patrons have the moral conviction *that to deliver tainted milk at a creamery is not only to steal from the creameryman, but also from their fellow patrons,* not until then, I say, have we any hope of a perfect product from our creameries.

It has been suggested to pay for milk not only according to fat percentage, but also according to grade, and that the milk be "scored" each day. Though this has been practiced in a few creameries in Denmark, I did not believe it to be practical, yet it seems to be gaining ground and may be realized by the formation

of milk scoring associations where several creameries combine and hire an independent man to make surprise scorings. This plan is to be recommended highly even before decision is made to pay accordingly provided the results are posted at the weigh can.

Cans in transit should be protected against sun and dust, and in very hot weather it will be found a good thing to cover them with a wet blanket, as the evaporation of the water will cool the cans.

To secure the desired co-operation, it is much to be preferred that the patrons take turns in delivery instead of having regular milk haulers. If these have to be employed, as great care should be used in selecting them as by our President in selecting an embassador. Unless the milk receiver knows the hauler to be a man of discretion, he had better not complain about the milk to him, but, if possible, call on the farmer in person, or ask him to call at the creamery.

CHAPTER III.

RAISING THE CREAM.

COMPOSITION OF MILK—CONDITIONS AFFECTING ITS CREAMING.

In 100 lbs. of milk is found an average of 87.5 lbs. water, in which is dissolved 3.75 lbs. casein and albumen, 4.5 lbs. of milk sugar, and 0.75 lbs. of ash. In this watery solution—"serum"—3.5 lbs. of butterfat, more or less, exists in emulsion.

The specific gravity of the butter globules is less than that of the serum (skim milk), that is, if a certain measure of water at 60 deg. weighs 1,000 lbs., the same measure of skim milk will weigh about 1,034 lbs., of new milk about 1,030 lbs., of cream holding 25 per cent. of fat 1,002 lbs., of pure butterfat (at 100 deg.) about 867 lbs.

These facts explain the process of creaming, which goes on if milk is left at rest. The fat globules together with some serum rise to the top and form a layer of *cream* while the skim milk retains more or less of the fat.

Various conditions affect this separation, notably the depth of the layer of milk and the temperature. It is evident that the thinner the layer of milk the sooner will the butter globules make their way to the top.

Cooling will, as the late Prof. Arnold pointed out, affect the serum and make it shrink faster than the butterfat, and thus increase the difference in the specific gravity and cause the cream to rise sooner. But while milk is being heated the opposite result is obtained and the cream will rise more slowly.

If, on the other hand, the temperature is stationary, the higher temperature is the more favorable as the butterfat expands more (though more slowly) than does the serum.

These facts explain why the "practical" dairymen often report various results and demonstrate the necessity of varying the system of setting according to the conditions ruling.

SETTING SHALLOW.

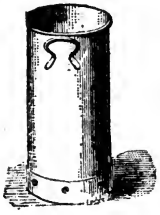
This used to be the common system in most countries, whether in the large Scandinavian and German shallow wooden tub, the French and English earthenware dishes, the large enameled cast-iron pans (Destinon), the Dutch copper basins or the modern tinned steel milk pan.

The depth at which the milk is set should vary according to the temperature in the room, and if very warm I have seen it set as shallow as 1½ inches, but if the temperature is 60 deg., the depth may be from 2 to 3 inches. The cream should be skimmed while the milk is sweet, but I have also got good results by doing it just before or at the very minute the milk is coagulated, and, if set in a clean room, free from odors, the resultant butter may be as fine as from any other system. Coagulation stops the rising of the cream. The cream is best removed with a flat, finely perforated skimmer, Fig. 9.

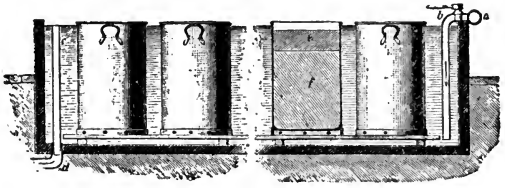
(Fig. 9)

DEEP SETTING.

The Orange County (N. Y.) system was, I believe, the first by which the milk was set in cans about 20 inches deep and from 8 to 15 inches in diameter—round (Fig. 10) or oval. They were



(Fig. 10)



(Fig. 11)

placed in running water from springs holding a temperature of 48 to 50 deg. This is satisfactory, and wherever such water is obtainable the dairy should be built with a tank of wood or preferably of cement, arranged as shown in Fig. 11, letting the water enter at the bottom at one end and flow out at the top at the other.

It was soon adopted in Sweden and elsewhere, and in 1864 Mr. Swartz suggested the use of ice water; and in that case, unless tainted by spilt milk, the water need not be renewed more than once or twice a month.

(Fig. 12)

This system soon gained ground and its application is very simple whether it be with a cut off whiskey (or other) barrel into which a single can is set, or with a larger tub for six or eight cans or large cement tanks with room for 50 or 100 cans. The ice should of course be crushed so as to find place between the cans and thus give an intensive cooling. (See Fig. 12.)

Prof. Fjord made experiments which showed that the very best results were obtained with cans 8 inches in diameter, and by using plenty of crushed ice so as to ensure a very quick cooling.

Later Dr. Babcock, of Wisconsin, reported the following average analyses of skim milk from deep setting at different temperatures:

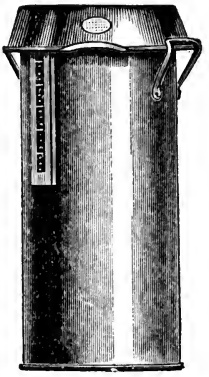
Ice water 35 degrees—45 degrees F.	.282	Per 100 lbs. of milk set	
" 48 degrees	.287	loss by not using ice	.065
" 54—56 degrees	.746	" " "	.514
" 58 degrees	.949	" " "	.717

And also how an average loss of .086 per 100 lbs. of milk may be caused by not setting the milk immediately after milking.

Meanwhile Mr. Cooley invented his cans (Fig. 13). The cover, like an inverted tin pan, allows the can to be fully submerged in the water while it lets the condensed vapor escape into the latter. The advantage of this system is the exclusion of tainted air. Fine insulated tanks, some of them provided with elevators, are sold for these cans, but if that is too expensive, a barrel containing such a can may be set in anywhere, if no special dairy room is provided. These cans are sold with and without a tube by which the skim milk is removed from the cream.

The advantage of the tube to the one-cow dairy is obvious, as the good wife may at any time withdraw a little milk without materially disturbing the creaming process. More exact separation of the cream is also possible than with the regular conical

skimmer used for all deep setting cans. Yet, if there should be any "sediment" it would be better to skim from the top. Experiments have shown that these cans are no better than the common shot-gun cans (Fig. 10) *as far as the cream raising is concerned,* temperatures being the same.



(Fig. 13)

A good many other fancy cabinet creamers are on the market in which the ice water cools the cans in the upper compartment and refrigerates the lower one, where cream and butter may be stored. Mosley & Pritchard's and the "Crystal" in the West, "Stoddard's" and "A. H. Reid's" in the East, are among these.

It is simply a matter of first cost, neatness, convenience and insulation. Provided the temperature maintained is the same, as good skimming can be done in the 60 or 75 cent shot-gun can, placed in a sawed-off whiskey barrel as in the finest cabinet creamer in the market.

While thus ice water or running water not warmer than 50 deg., makes this system a comparative success, it must not be forgotten that where warmer water than this is used, the result may be a loss of from 1½ to 2½ lbs. of butter (or nearly half) per 100 lbs. of milk.

Another drawback never emphasized enough in America is the fact demonstrated by Prof. Fjord that where all the milk is from cows in their last period of lactation (say from 7 to 10 months after calving), all the chilling in the world would not raise all the cream, and in that case the shallow system seems to be better. By heating the milk to about 100 deg. just before setting (done in many cases by adding hot water), this trouble is partly avoided.

SET ACCORDING TO CONDITIONS.

By keeping the conditions mentioned for these two systems in mind, we are led to modify them as the French dairymen do when they set their milk 10 to 12 inches deep in crocks, placed in running water of about 55 to 60 deg. Thus, in the south, where ice is scarce and a running spring of that temperature, or even 65 or 70 deg., is available, the shallow tin pans should be placed in a trough through which the water is led, the depth of the milk

depending on the temperature. It must be remembered with both the shallow and deep setting system that the best result is obtained by "setting" the milk as quickly as possible after milking. Delay, hauling or shaking in any way will prevent creaming. Nor will cold air do the same work as water of the same temperature; and stone crocks or glass jars will not conduct the cold (or heat) as quickly as tinned steel or copper.

THE DEVONSHIRE SYSTEM.

As another distinct system, must be mentioned that of Devonshire, where the milk is set in pans from 4 to 6 inches deep for 12 hours. The pans are then placed on the stove (or better still, provided with a double bottom for hot water) and the temperature raised to 190 deg., or not quite boiling, after which the pans are set in the air for another 12 hours. The result is a thick, heavy cream that may be removed in blocks—the so-called Devonshire cream.

PRINCIPAL OF CREAMING BY CENTRIFUGAL FORCE.

Mr. J. D. Frederiksen, in "The Dairy Messenger," explained the principles of the process in such a clear, condensed manner that I quote: "Tie a stone to the end of a string, take hold of the other end of the string and swing it around at a rapid rate. As the speed increases, the force with which the stone will pull the string increases at a much greater rate than the speed, and the weight of the stone seems to increase a hundred fold. This is due to the centrifugal force, so-called, the tendency of the stone to fly away from the center of revolution.

"When a particle of matter is swinging round a central point, the force by which it presses outward from the center of revolution depends upon the gravity, the speed and the distance from the center. Supposing a weight of one pound, w, to revolve around an axis, the distance from the center (the radius) being r feet, and the number of revolutions s hundred a minute, then the centrifugal force $f=3.4xRxWxS^2$. Consequently, if r is one foot, the centrifugal force will be:

For	100	revolutions	a minute	3.4x	1	3.4 pounds.
"	200	"	"	3.4x	4	13.6 "
"	400	"	"	3.4x	16	54.4 "
"	1000	"	"	3.4x	100	340 "
"	5000	"	"	3.4x	2500	8500 "

"In other words, for 1,000 revolutions a minute, the distance from the center (r) being 1 foot, the centrifugal force

is 340 times the weight of the matter; r being 2 feet, it is 680 times; r being 3 feet, it is 1,020 times the weight, etc. Supposing the weight of a particle of fat in the milk to be 10 weight-units, and that of an equally large particle of milk serum to be 11 weight-units, then the force by which the fat is naturally driven towards the surface by gravity only will be 11—10=1, while in the centrifugal machine making 1,000 revolutions a minute, with an average radius of 1 ft., the force will be 340x11—340x10= 340. Thus the tendency of separation is increased 340 times by the centrifugal forces, and if the speed is 5,000 revolutions per minute, the increase will be 8,500 times. This gives an idea of the efficacy of centrifugal creaming as compared with any gravity process, and also suggests the enormous strain to which the drum of a separator is subjected. Supposing a stick to make a thousand revolutions a minute around its center in the horizontal plane, at each end carrying a pail with milk weighing 60 pounds, and supposing the average radius to be 2 feet, then the force with which each pail will pull the stick is 340x2x60=40,800 lbs., or about 20 tons."

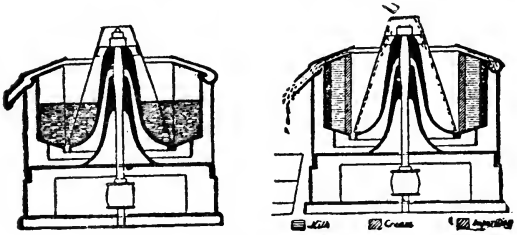
CONDENSED HISTORY OF THE CREAM SEPARATOR.

Prof. Fuchs, of Carlsruhe, in 1859, suggested the testing of milk by swinging it in test tubes. In 1864 Mr. A. Prandtl, of Munich, experimented with hanging cylindrical buckets with milk on a revolving spindle. In 1870, Rev. H. T. Bond, of Massachusetts, had two glass jars fixed on a spindle, revolving only 200 times per minute. In 1873 Mr. Jensen, of Denmark, had two pails revolving 400 times a minute. In 1872 Prof. Moser showed a model in Wien, and in 1874, Lefeldt, of Braunschweig, showed the first large separator. It consisted of a drum provided with a partial cover and four vertical partitions. It was encased in a heavy mantle.

The drum revolving 800 times a minute would keep the milk (220 lbs.) in a vertical position. It took 5 or 10 minutes to get up full speed, 20 to 30 minutes to separate and 25 to 30 minutes to come to a standstill again. When the milk had resumed its horizontal position, the cream floated in a heavy layer on top. The milk was removed with a siphon and the cream drawn through a valve in the bottom of the drum, which was refilled and the operation repeated. In 1878 the writer learned to operate this at

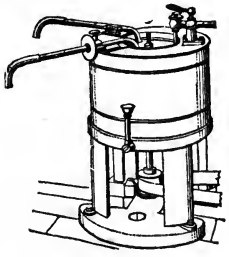
the Kiel City creamery, with the view of using it where ice could not be obtained and found the efficiency in skimming depended on the temperature, the speed and the time run.

It did not take long to improve on this crude process and the first move was to arrange for crowding out the cream when separated (as shown in Fig. 14), to the right; to the left the drum is shown at rest. This allowed the stopping of the drum by a brake, and thus shortened the operation. But, Mr. Lefeldt continued until in 1883 he had a machine receiving the milk and discharging the skim milk and cream continuously.



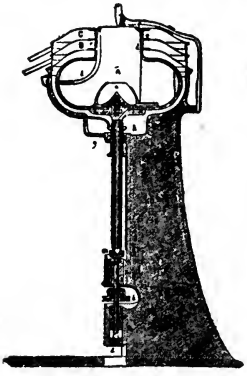
(Fig. 14)

Meanwhile other inventors did not remain idle, and as early as 1878 and 1879, the "Danish Weston" (so-called here) in Denmark and the DeLaval separators in Sweden were put on the market. The first had a plate just below the cover, with openings near the wall, and this forced the skim milk into the upper space, where a tube caught and discharged it, while another tube caught the cream below the plate. (Fig. 15.) This machine was run at from 2500 for the large one to 4500 revolutions per minute for the small size power machine.



(Fig. 15)

It had the great advantage of being able to elevate the cream, if so desired, 7 to 8 feet.

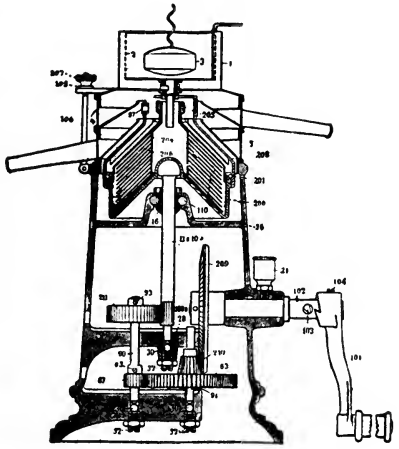


(Fig. 16)

The DeLaval Separator, on the other hand, had a smaller drum with a neck, Fig. 16, and there the skim milk was conducted through a tube (b) and thrown on a plate cover (B), while the cream rose along the neck and was thrown through an opening (e) on the plate (C). A small screw (f) regulated the amount of cream to be

taken. The speed of this separator was 7000 revolutions per minute, but operators often ran it up to 9,000 and above.

Among the numerous other machines that have been constructed, I mention a Danish one called the "Alexandra," in England, the "Balance" in Germany and France and "Jumbo" in America. The bowl rests loose on the spindle and thus balances itself. Fig. 17 represents the latest Danish make, which now,



(Fig. 17)

(Fig. 18)

since the original "Alpha" patents have expired, has been provided with plates similar to those used in the "Alpha."

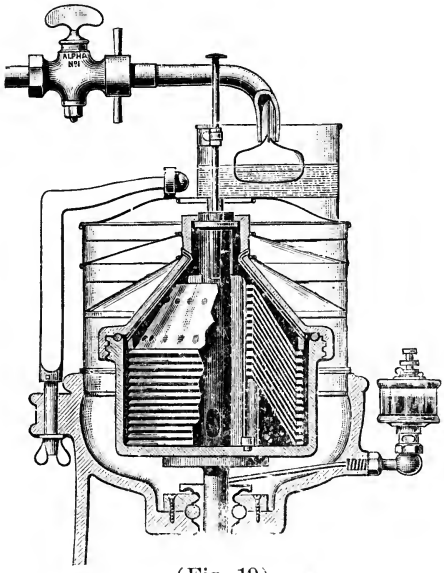
In England the *Victoria* discharges the skim milk at the bottom of the bowl.

In America *Sharples* first copied the DeLaval, and later constructed the "Russian," in which the bowl is provided with a steam turbine attachment, and is rotated by steam directly. Later he introduced his "Tubular" (Fig. 18), in which the bowl, nearly two feet long and only four inches in diameter, revolves about 22,000 times a minute, and he has now also put in an "insert" somewhat like the "Simplex" but with the blades screwed together.

The original Danish Weston were modified and greatly improved by Messrs. A. H. Reid, Springer and A. H. Barber & Co., but is not sold now.

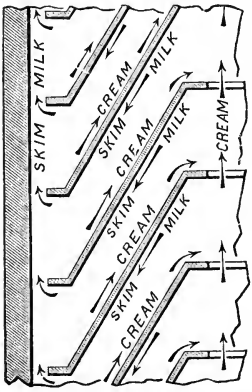
In 1891, the DeLaval Company adopted an improvement which consists of a series of discs (Fig. 19) which divide the milk into thin layers and this increases the efficiency of the

machine, so as to place it at the head of all in amount of milk skimmed per horse power used and in close skimming. It was introduced under the name of *"Alpha,"* and the work-



(Fig. 19)

ing is nicely illustrated in Fig. 20. The milk and cream have, so to say, each their own "sidewalk," the milk along the under side and the cream along the upper side of the plates as indicated by the arrows; and thus reach their respective destinations without jostling each other as in the case of the old hollow bowl separator. It is true, the price is somewhat higher and cleaning may take a little longer, but the fact remains that with the same power no hollow bowl machine has ever done as good work. The 1910 model of this separator is shown in the hand machine, Fig. 89. It is of interest to note that since the expiration of the Alpha



(Fig. 20)

(Fig. 21)

patent some half dozen or more manufacturers have adopted the discs more or less modified.

The discarding of the old ideas that the capacity of a separator depended exclusively on the temperature, speed, diameter and depth of the bowl, set many inventors to work experimenting to find a substitute for the Alpha Discs. Thus Melotte, of France, inserted a number of polygonal vertical partitions in the bowl, but later changed this to the insert shown in Fig. 21, and the capacity of the U. S. Separator was increased by dividing the bowl into compartments with two inner bowls, which caused a sort of triple current.

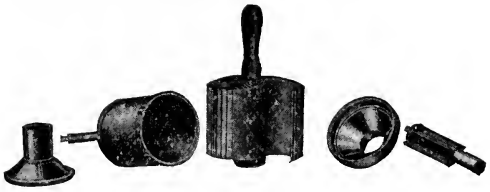
(Fig. 22)

The milk was fed into the top of the cover where tubes conducted it to the inner cup in which were wings that caused the milk to revolve with it. From here the milk passed into the intermediate cup and from there into the main bowl, so that before the milk left the bowl at the bottom it had passed through three different compartments. Later the inserts were changed as shown in Fig. 22.

Lefeldt filled his bowl with curious celluloid tubes; the "National" used cylindrical partitions indented like a pineapple, and A. H. Reid used corrugated cylinders. (Fig. 92.)

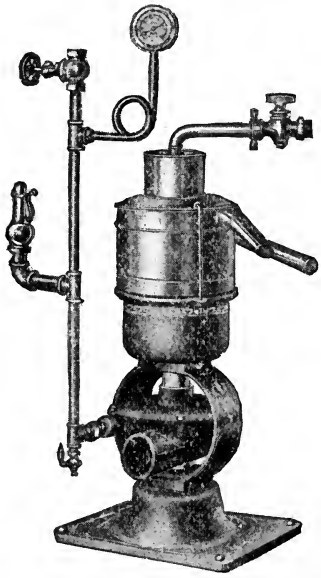
Lately D. H. Burrell & Co., of Little Falls, N. Y., have introduced the "Simplex" Link blade, called the "Globe," and other names in Europe. In these the milk pursues a straight course from the bottom of the bowl, where it is delivered by the feed tube, shown to the right in Fig. 23, to the top where it is thrown out as separated cream and skim milk.

The linkblades consist of a series of curved steel blades hinged on bronze rings, so that when taken out of the bowl they may be washed on both sides as shown in the center of Fig. 23.



(Fig. 23)

Each space between adjacent blades acts as an entirely independent separating chamber; all these spaces are fed uniformly at the bottom, and as the milk passes up it is gradually separated into the cream and skim milk, the heavier skim milk particles following the concave side of the blades in their upward and outward direction, and the cream particles following the convex side in their progress upward and inward to the cream outlet.



(Fig. 24)

In Fig. 24 I illustrate the No. 3 turbine "Simplex" with a capacity of 1,800 lbs. The "Crown" Separator made in Sweden had perforated decagon inserts, but the latest power machines have pyramids, reminding of the Alpha system, but the plates are deeper and have small openings near the top of each angle.

The "Empire," made in Bloomfield, N. J., is virtually the same as the Crown.

Finally the Burmeister and Wain Co. of Denmark, having given up the old "D. W." now make the "Perfect," with virtually "Alpha" plates and a self-balancing bowl patent Knudsen—a standard machine. Hand separators are shown in Figs. 89, 90, 91 and 92.

CHOOSING A SEPARATOR.

As to the choice of separators, no absolute rules can be laid down. Most of the hollow bowls skim so as to leave not more than 0.2, possibly 0.3 per cent. of fat in the skim milk, while those with inserts skim to between 0.1 and 0.2, by chemical analysis, and 0.05 to "trace" by the Babcock. Latest tests of the most modern makes show only 0.06 per cent. and 0.08 per cent.

by the Gottlieb method of analyzing. An extra loss of 0.1 to 0.2 per cent. means the loss of from 1 to 2 lbs. of butter for every thousand pounds of milk; if the amount skimmed is so small that the difference in the interest on the original cost is enough to equal the loss of fat, then there would be nothing gained in paying a high price for a close skimming machine. But in creameries, where the difference between the close-skimming of the separators on the market may make a difference of from 500 to 3,000 lbs. of butterfat, or, say, from $75 up to $600 a year, it is cheaper to buy the very best, even if the old ones must be thrown away. *Nor must it be forgotten that there also may be a difference in the individual machines of the same make.*

But there are also other considerations, the durability of the machine, cost of repairs, ease of cleaning and power required. Nor is a test of the skim milk enough. If the construction is such as to retain part of the cream in the bowl in a more or less unavailable shape, this loss should be calculated. Again, if all the skim milk is to be used for cheese or *for human* consumption, the fat left in it will have its full value and it matters less whether the separator leaves 0.05 or 0.25 per cent. of fat in it. If the milk is pasteurized (heated to 160 deg.) and run hot through the machine, the difference between the hollow bowl machines and the others will be reduced to a minimum as far as close skimming is concerned.

Whenever agents of rival machines are making comparative tests, care should be taken to see that the milk has the same temperature, that the speed and the amount of milk run in a certain time are exactly as claimed, that the test run is made as long as the longest run intended. (Fifteen minutes may leave very little fat in the skim milk, while an hour may leave much more), and that no juggling is done with the test. The double-neck Ohlson or the Wagner test bottle should be used, *not* the common Babcock. If you know a disinterested mechanical expert you can rely on, get his opinion as to durability of the competing machines.

COMPARING THE VARIOUS CREAMING SYSTEMS.

There is not a centrifugal separator on the market that is not far ahead of either shallow or deep-setting, even though these, under favorable conditions, for a short time each season, may leave as little fat in the skim milk as do the poorest separators;

the *"average"* will, at best, be about 0.5 per cent. and under unfavorable conditions go as high as 1 per cent. Experiments made by Prof. Fjord showed that even the original, self-skimming but crude, Lefeldt machine (with hollow bowl) gave more butter in per cent. as follows:

Ice System—May, 8.3; June, 7.3; July, 4.5; August, 3.1; September, 3.7; October, 18.1; November, 28.0; December, 17.8; January, 7.6; February, 3.8; March, 3.7; April, 4.1.

Shallow Tubs—May, 10.4; June, 9.6; July, 13.8; August, 11.0; September, 16.0; October, 14.9; November, 15.6; December, 13.1; January, 8.8; February, 5.4; March, 6.0; April, 6.4.

It is perfectly safe to calculate an increase of 10 per cent. on the yearly butter yield whenever a separator is used instead of the other systems, even under the most favorable conditions.

With either of the other systems the cream will not rise as well, if the setting is delayed or the milk shaken by transportation, but with the separator it does not matter nearly as much, nor will the period of lactation affect the separator much. We may have to reduce the flow a little—that is all.

It may be pertinent here to refer to the fact, shown by Dr. Barthel, that if milk has been agitated violently by running through a heater with fast revolving dashers or by being pumped up or elevated by a steam jet, the separators will not skim it as close as usual.

Tests have proved that cream and milk are purified by the separation which leaves a sediment on the bowl and in this may be found not only dirt and scales, which pass through the strainers, but also a considerable proportion of germs and bacteria, notably those of tuberculosis.

Add to this the increased value of skim milk, when we are able to feed it warm as it comes from the cow, and it is evident that no private dairyman having 5 to 10 good cows can afford to be without a separator.

CREAMING SYSTEMS THAT ARE FAILURES.

It would not be necessary to mention these if it were not for the fact that several otherwise respectable agricultural papers have run the advertisement of several such, and that even dairy papers are sometimes induced to give them space.

Thus we had, some years ago, the vacuum system, by which a small air pump exhausted the air from the milk can. This, like

creaming by an electric current, was, however, a short-lived delusion, and so was the famous Berrigan Separator, in which the air pump was used to create a pressure in the milk can and the milk diluted with 20 per cent. of water. The Cornell and Wisconsin Universities disposed of this. The former reported the tests showing the percentage of fat in the skim milk to be:

Laval Baby N2.....0.09
Cooley, set at 40 deg.....0.29
Berrigan Separator.....0.59

Not only was it a failure, but it was an attempt to deceive by using the word "Separator."

Creaming by dilution was attempted 41 years ago in Denmark and Germany, and many "practical" farmers reported good results, but that was in the ante-Babcock days.

Drs. Martini and Peters (Germany) tried it in 1869, and found that while apparently more cream was raised the cream contained less butterfat than that from undiluted milk, thus explaining the fallacious result claimed.

Every now and then during the last twenty years our agricultural papers have passed around notices of the wonderful benefit of dilution, various experiment stations took up the experiments, and while not all in accord, the results were not favorable to the process. Indeed the only experiments favorable to dilution that I recall are those reported in Bulletin 79, Cornell, which seem to indicate that while there is no benefit from diluting with cold water, some gain was observed from diluting with 25 per cent. of water at 135 deg. But, as there was a considerable difference in the temperature of the diluted and undiluted milk when "set" and the latter had the benefit of the higher temperature, those expriments are of but little value.

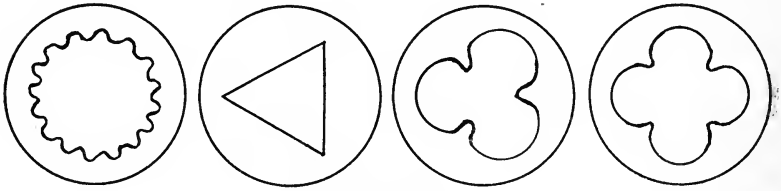
When comparing two methods, we must have all conditions alike, but the one to be tested; this is where many "practical" and, I regret to say, even some of the scientific experiments fail.

Theoretically, the addition of water, temperatures being kept the same, should rather delay the creaming, as it reduces the difference in the specific gravity, but if there is a benefit the explanation may lie in its preventing or delaying the coagulation of the fibrin discovered by Dr. Babcock.

The advertisements referred to are those of the *"Hydraulic,"* the *"Aquatic"* and other "Separators" (*sic*) which all profess to be patented and consist of a large can with a faucet into which the

dilution water is introduced at the bottom through a funnel or otherwise. The whole apparatus is sold for about four times its actual cost and farmers are misled by the term separator into comparing the low (?) price of $10 to $20, with that of $65 for the centrifugal separator. They have no more right to the name of separator than a shot-gun can. To this class belongs also the "*Automatic*" separator, which is a tube for distributing the water at the bottom of a can.

While most of these fakes are driven out of the market, there are still advertised in many agricultural papers so-called "separators" and "extractors," which consist of a peculiar shaped can inserted in another of galvanized iron. I illustrate in Fig. 26 the cross-sections of some of these cans and while they may not be called frauds my readers will notice at a glance that a common round can set in a barrel or in another round can with ice water will do equally good work and be easier to clean, while the cost is only one-third or one-fourth.



(Fig. 26)

CHAPTER IV.

HEATING THE MILK.

PREPARING THE MILK FOR SEPARATION.

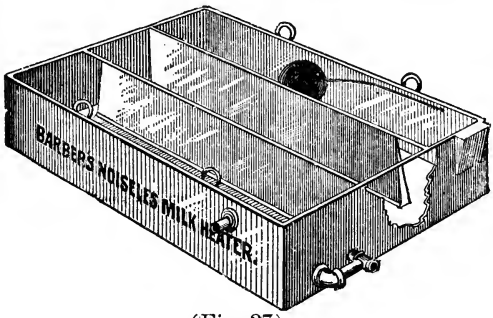
On the farm the milk is in its very best condition for separation immediately after milking, and the warm skim milk is then at its best for feeding purposes. Indeed, where convenient and where the separator is not too far from the stable it may be started as soon as the milkers are far enough ahead to keep it going and the milk may thus be strained directly into the separator tank, and thus save the cleaning of an extra vessel. But the separation should never be done in the stable or *anywhere* where smells and dust may contaminate the cream. If, by some accident, the supply of milk should not be kept up, a little water or skim milk should be run through the separator to drive out the cream. If the night's milk is not separated till morning it should be warmed to 80 or 90 degrees. This is essential with all hollow bowl separators, and only in a less degree with the others.

At the creameries the heating of the milk is an important function and is but seldom done in a satisfactory, uniform manner. The two principal systems used are, either heating the milk in a large body in the receiving vat, or passing it through some heating apparatus on its way from there to the separator. The danger of the first lies in the keeping of the—already old—milk at a high temperature and thus souring and developing bad flavors, and of the second, in the fact that the fat does not take the heat as quickly as the "serum" and thus the true temperature desired is not obtained, and also in the fact that no automatic regulator has been employed that would keep the milk from varying considerably. I have thus, even in good creameries, observed a variation of 10 deg. with heaters like Fig. 27.

THE HEATERS.

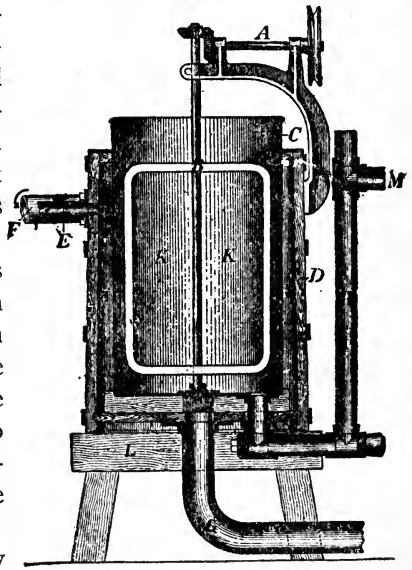
Most of the heaters used in our American creameries were similar to Fig. 27, which represents an improvement on the so-called "Danish Weston" heaters, but unless they are made

large enough they are not at all satisfactory. I presume their popularity lay in the fact that it requires only a few inches drop from the receiving vat to the separator. Similarly the "Larkin's" heater, a direct steam heater on the pipe conducting the milk from the vat to the separator, requires no drop at all and has been endorsed by many good makers, but I cannot say that I like the application of direct steam in any manner. There is always a certain risk of contamination, even if no boiler compound makes it a certainty.



(Fig. 27)

Far better to use the heaters—even if more expensive—as represented by the Fjord Heater (Fig. 28). This consists of a strong wooden barrel D in which a tinned copper vessel C is inserted. A stirring apparatus K prevents the milk, which enters at M through H, from scorching on the side. Steam is introduced by F if exhaust, and E if direct steam is used. Condensed water escapes through G. The milk outlet (not shown in the illustration) is above the wood.

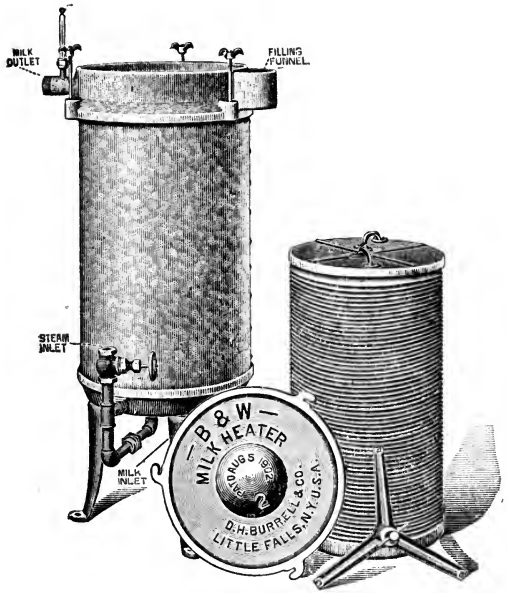


(Fig. 28)

This, with modifications and improvements, has been the common heater used in Europe and now elevates the milk to the separator, but the dashers must not revolve too fast so as to lessen the "skimmability" of the milk. (See page 34.)

The DeLaval Company have a neat little turbine heater, and so have the Jensen Mfg. Co., of Topeka, Kan., and Mr. A. H. Reid has copied the improved Danish. (Fig. 78.)

D. H. Burrell & Co. have put on the market a very good heater, and in Fig. 29 I show it taken apart for cleaning. This is claimed to heat up to 7,500 lbs. per hour.



(Fig. 29)

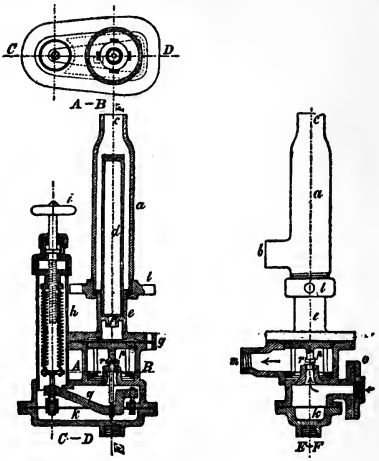
The Creamery Package Mfg. Co. have in their 20th century heater (Fig. 30) an evolution of the Streckeisen open air milk condenser. The Root Heater is a new construction of which I have no experience or report, but reminds of the Miller Tyson pasteurizer. Indeed it may be said that all pasteurizing heaters make good heaters for separating, but I hope to see the day when automatic heat-regulators will be used in connection with all heaters.

(Fig. 30)

I illustrate the one made by F. Casse which gives satisfaction.

Fig. 31 shows a horizontal and two vertical cross-sections—

cross-section C-D and E-F. A piece of the pipe by which the milk or cream is elevated from the pasteurizing heater is cut and the larger pipe (a) is substituted, so that the milk comes from the heater at (b) and leaves at (c). In this way the warm milk in rising surrounds the copper tube (d); this tube contains a mixture of ether and glycerin; the former floating on top being evaporated by the heat from the milk and the pressure thus created (which is correlative to the temperature of the milk) acts on glycerin and,



(Fig. 31)

through this, on the rubber diaphragm (g) and the piston (p). From this piston the pressure is carried through the lever (q) to the spiral spring in the compartment (h). This spring may be loosened or tightened by the wheel (i) and thus the resistance of the piston (p) against the ether pressure may be regulated.

The lower part (r) of the piston (p) forms a valve which, when the piston is pressed down, shuts off the steam which enters at (o) and leaves for the heater at (m). In order that the regulator shall not weigh down the steam pipe a pipe support is screwed into the lower part (k). When the rubber diaphragm has to be renewed (which Mr. Casse claims is only a few times a year) the piece (e) is removed, allowing the ether and glycerin to run out, the old rubber diaphragm (g) is removed and the piston (p) taken out and wiped off. The valve is cleaned and the piston replaced, the new diaphragm put in and the piece (e) is held with the opening up (f, Fig. 2) so that it may be filled first with a small quantity of pure glycerin and then with ether. The opening (f) is closed with a small cork so as to hold the ether and glycerin, while the piece (e) is replaced and bolted. When the regulator is heated up the bolts should be tightened, if necessary. As soon as the ether expands the little cork is forced out and the glycerin runs out and presses on the diaphragm.

It must be observed that it is necessary, to insure good work, that the copper tube (d) *is cleaned every day* and kept free from the inevitable film of dried on milk. To do this is easy as the elevating pipe (a) may be removed by loosening the union (l).

FILTERING MILK FOR SEPARATION.

The milk is generally strained into the receiving vat in a more or less, generally less, effective manner, through muslin, and if all the patrons sent absolutely clean milk, even this might be omitted, yet the average condition of the milk I have seen received at our creameries has led me to consider the advisability of filtering it. For this purpose the "International" Filter would be the best of those I know of, but whatever is used, strainer or filter, it will be a delusion and a snare if not kept absolutely clean and—after all—the game is not worth the candle.

In running the milk from the heaters to the separator it is a very bad practice to use rubber hose, and even common galvanized pipes should be condemned. Take exact measures and have copper or brass tubing, *heavily tinned,* made to fit the distance, joined with unions, and do not have any one piece longer than 4 feet, so as to make cleaning easy. The extra cost will be as nothing compared with the advantage. It is a pleasure to note here that the past year (1909) has been conspicuous by the advertising and selling of more or less real *sanitary* fittings.

CHAPTER V.

CREAM RIPENING.

If cream is churned perfectly sweet it will have a very faint aroma and an insipid taste, and the demand for such butter is very limited. For this reason, all those who have no special orders for it should ripen the cream before churning.

NO UNIFORM RULES POSSIBLE.

It is evident that if we desire to churn the cream at a certain degree of acidity (and age) our treatment of the cream must vary according to the system by which it was raised. It stands to reason that cream which has been raised for 36 hours in a shallow pan, perhaps not skimmed until the milk was loppered, needs not the same treatment as that whirled out of a separator within an hour of milking time. Then, again, that raised in ice water needs a modification in its treatment, just as cream in a separator creamery must be treated differently from that in a gathered cream creamery. A difference must also be made if we churn every day or only every other day or once a week.

BUTTER FLAVOR AND COMPOSITION OF BUTTERFAT.

As indicated, the object of ripening is to develop that peculiar aromatic flavor which is characteristic of all fine butter. But what really causes this flavor is as yet a mooted question among scientists.

Years ago when the chemists ruled the roost, the flavor in butter was credited exclusively to the so-called volatile fatty acids. Butterfat, it must be understood, consists mainly of Palmitin, Stearin and Olein, which may be found, more or less, in nearly all animal fats; butter contains, however, six other substances.

Some of the "fatty acids" are volatile, and it was maintained by chemists that the action of the casein and milk sugar in the butter on these "fatty acids" developed various fine odors which soon turned into the disagreeable, rancid odor and taste.

Later the bacteriologists claimed that the aromatic flavor was

simply due to certain microbes, and at one time the hope was held forth that the dairymen could be supplied a "pure culture" which would provide the desired flavor.

In this we have been disappointed up to date, and it proved true that the question was not quite so simple, and that flavor depends on more than one breed of microbes. This is, in my opinion, a good thing for the dairymen, because if the development of flavor could be made such simple and exact science the creameries might as well leave butter-making in the hands of the packers.

To me—as a layman—the theories of the chemists and bacteriologists seem to supplement each other and confirm my practical experience in buttermaking. It matters not to me whether the flavor is the result of the action of certain microbes or that of their chemical products on certain parts of the butterfat, but practical experience tells us that the chemists must be right in so far that the desired flavor is *developed* in the manufacture. Pure butter oil has little or no flavor, sweet cream butter but a trifle more and the more we ripen the cream (up to a certain point) the more we increase this flavor. On the other hand we also know that feed and external conditions have some influence on the flavor and that June and July butter is ahead of winter butter.

Analyses have shown (Fleischmann quoting Bussaingault) that summer butter contains 40 per cent. hard fats and 60 per cent. soft, while winter butter contains 65 as against 35; hence, the latter is much firmer and stands up better.

Other chemists have also shown that, for instance, feeding an excess of cotton seed meal will increase the percentage of hard fats (Palmitin and Stearin) and linseed meal will decrease them. Hence the now well-known variation in churning temperatures and firmness of the butter.

Danish experiments have shown that leaving cows out in the fields in stormy and rainy fall weather will have the result that, even if they are fed exactly the same as those comfortably stabled, the percentage of volatile fatty acids is reduced to such an extent that English chemists suspected the butter to be adulterated and practical butter experts scored it low in flavor even if the cream had been ripened to the same degree in both cases. (Hence, the general complaint in fall of "wintry" flavor on our markets).

It seems to me that the theories of the chemists agree perfectly with the experience of the practical buttermakers.

The chemists attempted to produce a "butter flavor," but they have not been able to provide oleomargarine with the desired aromatic flavor any more than the bacteriologists. Nevertheless, the latter have—by combining more than one breed of bacteria—succeeded in producing commercial "starters" which, when made by reliable firms, give a uniform and satisfactory result, but in no way better than that obtained from good home made "starters." Where uniformity is of importance the commercial starters are to be recommended. We have *Hansen's Lactic Ferment, Douglas Butter Culture,* B 41, *Keith's* and *Ericsson's Cultures* in the market here.

While introducing these, a great deal of educational work has been done by the various firms, showing the buttermakers the great importance of the ripening process, and thus in reality reducing the variation in flavor caused by feed, climate and period of lactation, but only in one case (Iowa Experiment Station) have tests been made resulting in the assertion that the difference may be wiped out altogether by careful high ripening, that, in other words, just as fine flavored butter can be made from strippers' milk as from that of fresh milking cows; but these results have as far as I know, not been confirmed.

Yet, the fact remains that cream-ripening is the most important part of buttermaking, and that, as I said years ago about cheesemaking, "*Acidity—like salt and charity—covers a multitude of sins.*"

RIPENING CREAM ON THE FARM.

Let us now come down to the practical handling of cream on a small farm. A common way is to keep the cream in a stone jar, and, if any attempt is made at ripening, to place it near the kitchen stove. Stone jars, if there are no cracks in the glazing, are all right, but not very convenient to handle, and especially troublesome when it is desired to change the temperature. Take it all in all, there is nothing better than a clean, heavily-tinned and smoothly soldered steel or copper can. In this the temperature of the cream may easily be changed by placing the can in a larger one or in a tub with water. The warmer the water the more important it is to stir the cream so as not to overheat part of it. It is safest not to have the water more than 120 or 140 deg.

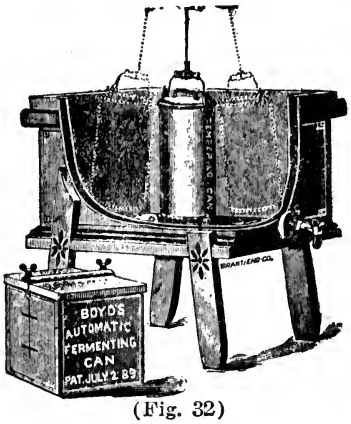
When the right temperature is obtained the can should be

placed in a box or barrel large enough to have about six inches insulating material (hay will do) round the can so that the temperature may be kept from falling much, even if we have to keep the can in a very cold room, kitchen, damp cellars and living rooms being barred.

When it is desired to cool it, the can is simply placed in a barrel of cold water and kept there, changing the water or adding ice as needed.

This is the simplest and cheapest way which any one could desire, but, if we can afford it, the hay box may be replaced by one into which a can (large enough to hold the cream can) is permanently fixed, keeping the insulating material in place and having an insulated cover. Or, in a larger dairy, the Boyd farm cream vat (Fig. 32) may be used. The vat is insulated with felting and the temperature is changed by swinging a tinpail (with either hot or cold water) in the cream. Or we may have a little square or round vat made on the plan of creamery vats, all according to our means, as long as we keep in mind the necessity of being able to change the temperature at will and maintain it without too much trouble.

If churning only twice or three times a week, the object must be to keep the cream as cool as possible, up to within 12 or 18 hours of churning time. The warm separator cream should be cooled before adding it to the previous lot in the can. Another way, where there is plenty of ice at hand, is to let the cream become *nearly* ripe and then cool it down to 45 deg. and keep it there, when it may safely be kept for 24 hours.



(Fig. 32)

If shallow pan cream is used the cream will be nearly ripe and, as a rule, will be ready to churn 12 hours after adding the last batch without raising the temperature. It may indeed rather be necessary to provide for cooling it so as to secure the desired churning temperature. Cream of different ages should never be churned together, without having been mixed together for at least 6, better 12 hours, and it should be well stirred as each batch is added.

JENSEN CREAMERY MACHINERY CO

If cold water or ice deep-setting cream is used, it may be kept in the same cold water tank until 12 hours before churning and then the temperature should be raised to 60 or 70 deg. either in the manner before suggested or by heating the last cream (but not higher than 100 deg.) before adding it. If this is done, it is well to do a little calculating. Let us say that we have the cream from three milkings, in all 30 lbs., and find the temperature to be 50 deg. and that we have to raise it 15 deg. This is 15x30, or 450 heat units. Divide them with the weight of the last cream (10 lbs.) and we find that this must be heated 45 deg. above 65 deg. or to 110 deg. in order to get all to 65 deg. Remember to make sure of the temperature by reading the thermometer twice with 5 or 10 minute interval. With separator cream the last batch should be added 20 to 24 hours before churning, and, as a rule, a little higher temperature should be used, say 65 to 75 deg. If we use a "starter" 60 to 65 deg. may be enough.

It will then be seen that no fixed temperature can be given. We want to reach a certain degree of acidity and if the original acidity (system of raising or age of cream or addition of a "starter") is the same then the temperature to be used depends, within certain limits, on the time we desire to devote to it. Personally, I prefer the given temperature for farm work so as to get the cream ripe for churning in 6 to 12 hours for shallow and deep-setting and 18 to 22 hours for separator cream.

CREAM-RIPENING IN CREAMERIES.

It will, however, also depend on the facilities we have for cooling the cream just before churning. Thus I know creameries that use 48 hours and a temperature of only 50 to 55 deg. with good success, and while I consider that temperature conducive to development of poor flavors, there are creameries where the practical exigencies demand it on account of lack of cooling facilities.

Where the very best cooling facilities exist, I would much prefer to hasten the ripening and use even a higher temperature than mentioned above, let us say between 75 and 85 deg., which, together with a "starter," will nearly ripen the cream in from 6 to 7 hours and thus allow it to be cooled to 60 or 55 deg. before bed time, and then ripen fully while cooling further during the night. As a rule one hour's cooling in the morning will then bring it down to the lowest desired churning temperature.

The common cream vats used in American creameries up to six or eight years ago were the rectangular tin vats hung in a wooden, watertight tank, which allow for a space with hot or cold water. Some of them are provided with space into which to put ice. Some are made U shaped and these are better still, and others, the twin vats, have two narrow vats in one jacket. (Fig. 33). It is evident that a large body of cream is only slowly heated or cooled in these and that constant stirring is necessary,

(Fig. 33)

hence we find that many makers are obliged—often against their better conviction—to use ice directly in the cream. If perfectly pure ice (made from distilled water) is used, and it is crushed fine and kept stirred until dissolved or nearly so, there is no harm done. But pond and stagnant river ice is a fearful source of all kinds of contamination and, if it is left in large lumps without stirring, the cream will be unevenly ripened, so that this system of cooling should be discouraged.

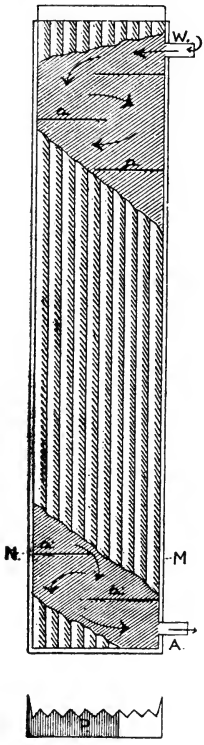
The fact is that the question of giving the creamery buttermaker complete and quick control of the temperature in his cream has not as yet been solved satisfactorily, but since the introduction of refrigerator machines a very great step ahead has been taken. Thus the cream room itself can now be kept at a uniform temperature of 50 to 60 deg. (instead of 70 to 90) and there the temperature of a large vat of cream will not rise or fall much during the night.

As to the cooling in the vat various systems have been tried. In one creamery they tried to cool it with the air by having the vats without jacket, but experience taught them what they might have known, that air does not conduct the heat (or cold) as well as water.

Others have placed ammonia coils in the water space of the

jacketed vats, and that has done fairly well, though it were better still to have the vats of tinned copper in which case brine could be circulated and the cooling done much quicker, but the cream must be stirred in both cases until the desired temperature is reached.

Cooling the cream to ripening temperature, even if as low as 60 degrees, is the simplest matter and can best be done by substituting an improved Baer Cooler for the conductor from the separator to the vat. In this way hundreds of creameries could cool and aerate the cream sufficiently even with water. If it is made of copper the brine system may also be applied. In Fig. 34 the cross-section shows the corrugated surface which compels the milk to run in the little gutters and increases the cooling surface, as well as the partitions (p) which turn the current of the water which flows as the arrows show on the exposed part of the sketch. The cream flows, of course, in the opposite direction and on a length of 8 feet, 2 inch drop is fully enough; indeed, they may be placed nearly level. I cannot recommend these coolers too much where the cream is not too rich, and where the air is pure.



(Fig. 34)

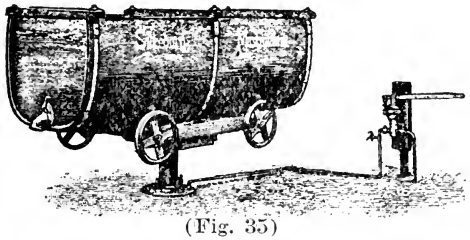
The great trouble is to change the temperature in a large vat of ripened or nearly ripened cream with reasonable dispatch.

It is done in some creameries by having an extra cream vat and pumping the cream to be cooled over a direct expansion (or brine) cooler.

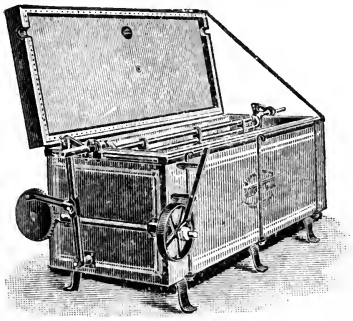
In 1897 I suggested to use vats (holding one churning only, say 1,500 lbs.) on large castors in a refrigerated cream-room. The cream being cooled to ripening temperature on its way from the separator, is, when nearly ripe, elevated on a large elevator and run over a cooler L into an extra vat. When churning time comes the vat is again elevated and the cream run through a conductor to the adjacent churn room. The advantage is to have no pumps and yet have everything on one floor, the disadvantage is the cost of elevator. The system has not been tested in practice. In Den-

mark hydraulic elevators are used in several creameries; they are either fixed or on wheels (see Fig. 35) so they may be run into the refrigerated cream room, whereby the same result is obtained.

Of other cream vats should be mentioned the Boyd vat, Fig. 36, in which a coil moves slowly back and forth. (Mr. H. B. Gurler, I believe, first constructed and uses even now, one in which the coil, hung by its four corners, is lifted up and down, and that style is now sold under the name of the McAreavy Cream Cooler.) Hot or cold water or brine is passed through the coil. Mr. Boyd had no water space, but insulating felt around the vat; he also made "Starter" or Fermenting cans as shown in Fig. 32, and part of his system is to close up the cream air-tight and not stir at all while ripening. With perfect milk this is all right, but at our creameries where the milk is often far from perfect, I prefer stirring and aeration, especially during the first hours.



(Fig. 35)



(Fig. 36)

Another cream-ripener, as these vats are miscalled, was the "Farrington," an evolution of the "Potts" pasteurizer.

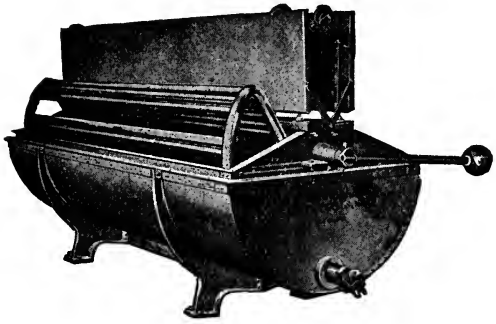
Finally we have the Jensen, with a spiral coil, the Miller, the "Wizard" vat (Fig. 88) and the "Simplex" (Fig. 37.)

Control of temperature and ease of keeping everything most scrupulously clean are the most important requisites, and, if an acid test is used, the maker should have no difficulty in securing uniform results in ripening.

As soon as all the cream is in the vat see that the temperature is right and take the degree of acidity of the cream and of the "starter" if such is used, also the temperature in the room. Add starter as experience has taught you will be needed and stir thoroughly. Stir every half hour or so for the first 3 or 4 hours. In the evening before leaving it for the night, take the temperatures in cream and room as well as the acidity of the cream. If

needed, raise or lower the temperature so as to have it right next morning. After some practice you will soon be able so to regulate matters that you will not only have the right acidity but also nearly the right temperature within half an hour or so of the time you want it.

SIGNS OF RIPENESS.



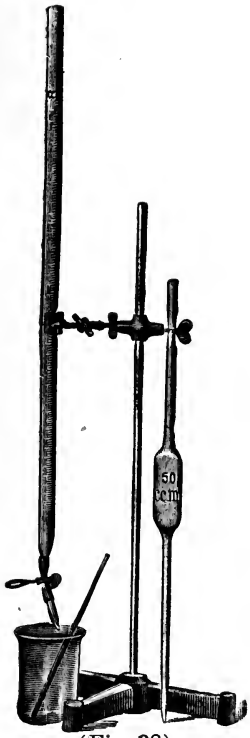
(Fig. 37)

To tell in printer's ink when cream is ripe is very hard; the nearest I can get is that it should have a clean, pleasant acid taste and smell and a smooth, even, syrup-like consistency, so as to run evenly and smoothly from the stirring paddle and have a peculiar, glossy surface. But even the finest nose and palate may get out of order, and hence the Mann's (Fig. 38) or Prof. Farrington's acid test should be used in creameries. In dairies I do not recommend it for other than experimental purposes. To get the highest flavor, Prof. G. L. McKay has found that 35 to 38 cc. is the best, and I have had good results between 33 and 39 cc. The former is about 0.65 to 0.68 per cent. acid, whereas Prof. Farrington recommends 0.6 per cent.

When we speak about cc. it means that it takes so many cubic centimeters of 1-10 normal alkali to bring out a pink color in 50 cc. milk or cream, to which has been added a few drops "indicator."

I refer to the book on *"Milk Testing"* and shall only lay stress on the fact that the test can be used only as a guide for comparing our own work, and even then we must look out for two causes of variation—richness of the cream and the weakening of the normal. In comparing with others we have these troubles as well as that of the variation in the eyesight. Hence, no rules can be laid down any more than for temperature used.

The Mann's test might well be modified to use only 10 cc. and thus not use so much cream, and to read off the per cent. acid at once.



(Fig. 38)

Commercial starters have been mentioned before and the manufacturers give full directions for use. Remains only to suggest the making of a good home-made one.

The milk used should be from a fresh-milking, healthy cow and extra care taken to secure it in a cleanly manner. Run it through the separator before the other milk (so as to have the machine clean), condemn the first quart or so run through and gather as much as needed in a carefully cleaned and *boiled* can. Or, set it in ice water for 12 hours in a *boiled* can, skim the cream and dip out what's needed without disturbing the bottom layer, for fear there might be some sediment.

Skim milk thus secured is better than new milk, but if either of these two skimming systems cannot be used it is better to use new milk.

Regulate the temperature (in a hot water bath) to 85 or 90 deg. and place the can in a hay box, or where the temperature will not drop below 75 deg. and leave it undisturbed until loppered. It should be watched so that when loppered it may be used soon after, or removed *at once* to a refrigerator or hung in ice water. Care should be taken not to shake or disturb it, so as to break the curd and let out whey. If thus chilled at once it may be kept in good condition if undisturbed for 24 hours or more.

When it is wanted for use, skim an inch off the top (as this may have become contaminated), dip out all but the bottom layer, and stir it up well so as to have a homogeneous, smooth mass, which should have a clean, sharp acid taste, and a pleasant aroma, and, if, when first cut, it showed a clean solid face without bubbles or pinholes, it should be all right. If it is in any way tainted, condemn it and ripen the cream at a higher temperature without starter.

In creameries where they cannot get enough *"perfect"* milk to make the starter, it is better to get a quart or two from two or

three of the best patrons, and thus prepare two or three "mother" starters and, when coagulated, select the best to use in developing the starter by taking sufficient of the regular skim milk and heating it to 180 or 190 deg., keeping it so for 20 minutes and cooling it to about 90 deg. and adding 5 to 10 per cent. of "mother starter" prepared as above described. In 24 hours there will be enough "starter" besides ten per cent. to develop enough for next day's use with another batch of pasteurized skim milk, and so on.

For creamery use there are now in the market several "starter" cars of more or less merit. They are really a sort of pasteurizer where the cooling is rather slow.

I mention the "Haugdahl," the "Jensen" and illustrate the "Victor," Fig. 39.

Take care not to fall into a rut and use the starter automatically. This refers to all starters.

Add the desired amount to the cream and stir well, perhaps a little more during the first hour or so than when no starter is used.

(Fig. 39)

If today's butter is perfect it is safe to preserve some buttermilk free from salt and water (by chilling in ice water immediately after churning), and use that as a starter; but, it is evident that if there is any fault in today's butter the buttermilk will perpetuate that fault even if next day's cream is *perfect.*

There is the same objection to using part of today's ripened cream as a starter for the next batch, nor do I believe that cream makes as nice flavored a starter as skim milk.

Thus "many roads lead to Rome" even in the matter of "starters," and judgment must be used. I do not believe in using more than 3 or 4 per cent. for unpasteurized cream, and 8 to 10 for pasteurized, but I should always use more starter for a very rich cream than for a thin one, and still more when trying to improve gathered cream.

The Canadians have lately claimed a great deal for a new system of cream ripening or rather *butter ripening,* whereby the starter is prepared the day before and added to the cream (as soon as it has been skimmed and cooled to churning temperature) when put in the churn. This has the advantage of saving the work in watching the cream from one day to the other, but I confess to some dread lest we lose control of the ripening if we rely on its progress *in the butter.* I shall require more evidence before I am converted to that system.

CHAPTER VI.

CHURNS AND CHURNING.

THE THEORY OF CHURNING.

The oldest theory of the churning process was that the little fat globules in the milk were covered with a membrane which had to be torn before the globules would adhere together and form butter granules (pellets). This should be done in the churn and it was also claimed (Romanets) that the souring of the cream would dissolve this membrane or skin. This theory was upheld to the last by the late Prof. Arnold.

Later it was disproved in several ways by various scientists, while the practical makers went on and found that having the cream of a certain ripeness and temperature, they could, as a rule, rely on the butter "coming" on time. (Speaking of temperatures it is amusing to notice how in olden time the "wise women" used to drive the witches out of the cream by putting in *red hot* horse-shoes in it.)

Later, again, Dr. Storch (Denmark) published the result of a long series of investigations, and concludes as follows: "If the old theory of a membrane round the globules is not adopted, then the only explanation is that the serum in the cream is split up in two parts during churning, one, containing more albuminates, going into the butter, and the other, containing less, forming the serum of the buttermilk."

But we need not bother our brains about these theories, it matters not whether a membrane exists or whether simply the serum adhering to the globules is of a different composition, though it seems to me the latter theory is indirectly confirmed by Dr. Babcock, who asserts that the small amount of fibrin in the milk has a tendency to adhere to the globules and delay the creaming.

CHURNING TEMPERATURES.

The various conditions which have influence on the choice of the churning temperature may be classed as follows:

(1.) *The composition of the butterfat.* (a) Different breeds seem to produce butter of different firmness, thus the Jerseys give the firmest butter and require a higher churning temperature—all other conditions being equal. (b) The longer

the cow has been in calf the firmer becomes the butterfat and hence the churning temperature must be higher. (c) Effect of feed is illustrated in the cotton belt where excessive feeding of cotton seed makes a churning temperature of 70 to 72 degrees not uncommon. (d) Different seasons.

(2.) *The acidity of cream.* Prof. Fjord demonstrated years ago that sweet cream must be churned at a lower temperature than that ripened—all other conditions being the same.

(3.) *The richness of the cream* has also an influence in so far that a rich cream (say with 25 to 35 per cent. fat) may be churned at a much lower temperature than a thin one (below 20 per cent.) and thus reduce the loss in buttermilk. This Mr. H. B. Gurler demonstrated first, churning the former as low as 46 to 50 deg., while the latter cannot be churned much below 56 deg.; if too cold it will foam.

(4.) *Construction of the churn* as well as speed and amount of cream in the churn should also be considered in determining the *starting* temperature, as the heat produced by the different mechanical actions may vary greatly.

(5.) *The temperature in the room* should also be considered in choosing the starting temperature of the cream, and not only made a trifle lower in a warm room than in a cold one, but the churn itself must either be cooled or warmed or else the difference in the starting temperature must be made greater. It is indeed also necessary to have the finishing temperature vary a little according to that of the room.

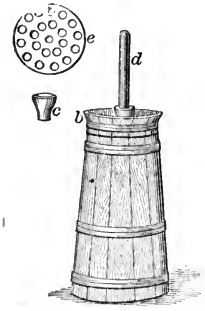
It is thus shown that no fixed rules can be laid down, yet the limits may be said to be from 56 to 70 degs. for cream testing 20 per cent. or below, and from 48 to 60 degs. for rich cream. I believe that when it is found *necessary* to use the highest temperatures the butter will be "stearinyy" and, as a rule, deficient in flavor. Experience will soon teach us the right one and as a general proposition churning should be finished in from 20 to 60 minutes to get the best result.

The thermometer may be wrong, indeed I have found them to vary 10 deg., and hence the necessity of finding the right temperature by the thermometer in use. It is well—if it can be afforded—to buy a standard certified thermometer at $1 or $1.50, and hang in the parlor in order to compare the cheap ones in use at various temperatures. But it should not be exposed to repeated and violent changes as that will spoil the best one in the course

of time. Of the cheap ones I prefer a plain glass one (floating) to those fixed on wood or metal—they are easier to clean.

CHURNS.

I doubt if there is any other implement on which more patents have been taken than on the churn, thus in the United States 2,955 were taken out from 1800 to 1904, and yet how few new principles have been developed! About 2,000 years ago Pliny described an up and down dash churn very much the same as the one yet made and sold in most countries (Fig. 40) in which just as good butter can be made as in the very latest "patent," even though it does take more work, and leaves more fat in the buttermilk.

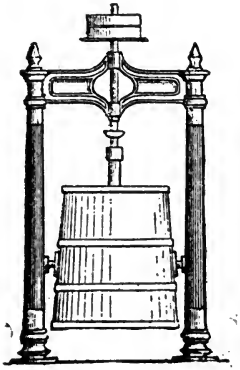


(Fig. 40)

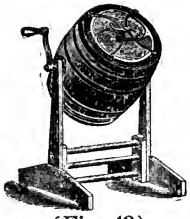
The old Russian Churn (Fig. 41 from Martini's "Kirne and Girbe"), which is a stone jar in which the stirrer, provided with anchor-like prongs, is twirled round and round between the hands, may yet be found in northern Europe, and may be said to represent our modern revolving dash churns, of which the Danish (Fig. 42) represents the vertical and the "Blanchard" the horizontal system.

Another development was the revolving barrels with various kinds of fixed dashers, such as the old Swiss "Grindstone" churn. But evolution simplified these to the end-over-end revolving barrel.

(Fig. 41)


(Fig. 42)

(Fig. 44.)

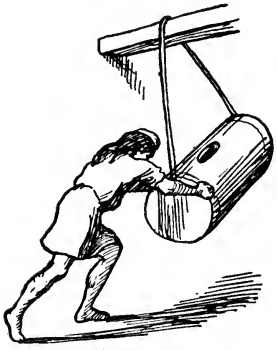


(Fig. 43)

(Fig. 43), and the Curtis rectangular churn, which may be said to be the two most popular dairy churns in the West.

The old Arabian churn, made out of the skin of a goat (Fig. 44), which still holds its own among many tribes in Africa, and the hollow log (Fig. 45) used in Asia Minor are both prototypes of the modern Davis Swing churn (Fig. 46) which is quite popular in the Eastern States.

While in Europe the creameries generally adhere to the vertical churn with revolving dashers (Fig. 42), the large box



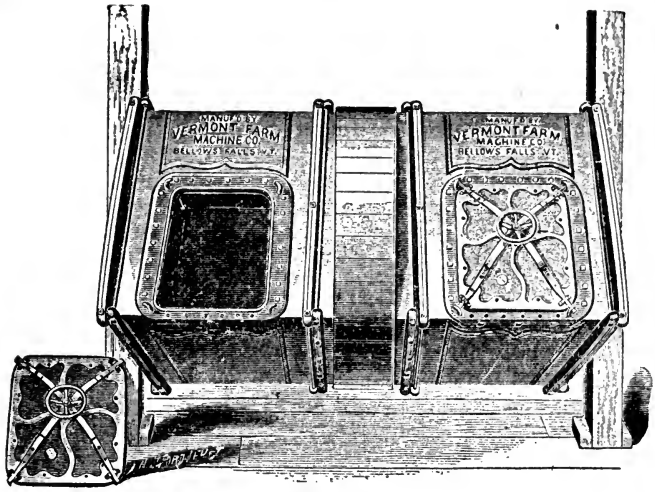
(Fig. 45)

(Fig. 46)

churn (Fig. 47), of which some are made to open like a trunk, (easier to clean and aerate, but harder to keep from leaking while churning), kept their ground here until the combined churns have taken their place to a great extent, first in the Western States, then East and lately in Europe as well.

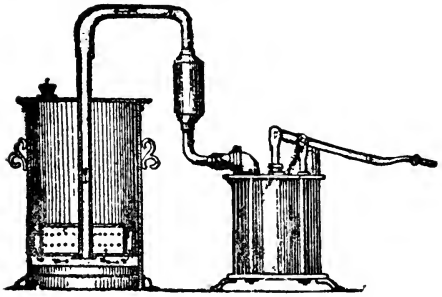
In 1840 Mr. Clifton introduced air through a hollow up and down dasher and in 1896 or '97, a Mr. Norcross introduced it through a hollow revolving shaft with a kind of turbine attachment, as something new and wonderful. Neither has any more value than the innumerable patent (?) lightning churns.

Next must be mentioned churning with air bubbles forced into the cream by an air pump, first proposed by Doehn, of Berlin,



(Fig. 47)

in 1887, and in 1889 by Walter Cole, of Melbourne, Australia. I illustrate this system in (Fig. 48), the Rolands (France), and, while no special advantage has been demonstrated as to the mechanical effect of this system, (rather the reverse) I believe, that for certain purposes (churning cream more or less tainted), it might have some effect in improving the quality. Experiments made in Illinois, however, proved it to be impracticable on a large scale.



(Fig. 48)

Combined churns and butter workers will be discussed in a later chapter.

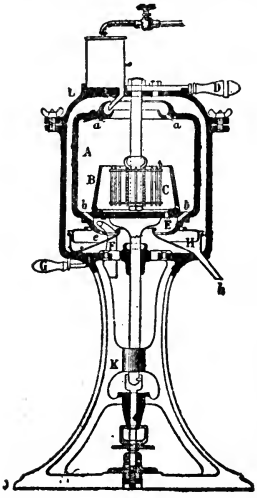
CONSIDERATIONS IN CHOOSING A CHURN.

In buying a churn the following points should be considered: (1.) *Ease with which it is cleaned.* (a) Close grained hard-wood is better than any softer wood, hence white-beech and oak or ash are preferable to pine, but in large box churns the element of warping must be considered. (b.) The fewer corners and projections, (fixtures), and the more air and light that can be had (large openings) the better it is. (c.) Glass peepholes, fixed thermometers and putty should not be tolerated; with a little experience there is no need of looking very often, and then the cover may be removed. (d.) Of dash

churns those with movable dashers are preferable to those having them fixed. (2.) *Exhaustiveness in churning.* Conditions being right for the churn and cream in question the exhaustiveness will as a rule be nearly the same, provided the time used is not less than 15 or 20 minutes. In all so-called lightning churns claiming to finish in from 2 to 5 minutes the loss of fat in buttermilk will be great, and the quality of the butter inferior. If you want to test the exhaustiveness of a churn, use it exactly as the manufacturer tells you and then test the buttermilk. If it does not show more than 0.3 for thin cream and 0.2 per cent. for rich cream, churned at a low temperature, you may indeed be satisfied, but in practice I fear that the variation is from 0.3 per cent. to 1 per cent. (3.) *Power* required to churn a given quantity should give way to the other points. (4.) *Solidity* in construction. (5.) *Condition* in which the butter comes. If you have followed the manufacturer's instructions, the butter should come in nice, regular granules, and not too soft. Yet, if you otherwise like the churn, you may, by lowering the temperature or otherwise changing the conditions (speed), find it satisfactory, even if the time used is longer than claimed. (6.) The last thing to be considered is the cost.

COMBINED SEPARATORS AND CHURNS.

Mr. Johnson, of Sweden, first invented the "Extractor," (Fig. 49), a separator inside of which a churn apparatus (c) churned the sweet cream as fast as separated and consequently produced sweet cream butter. Later Mr. Wahlin, also a Swede, constructed the "Accumulator," a similar combination, and the latest is the *"Radiator,"* a wonderfully perfect machine, with a separating room in the lower, and a cooling device and a churn in the upper part of the bowl, but the product—"sweet cream butter"—does not seem to take well on the English market, according to the last report of the Swedish Dairy Agent.



(Fig. 49)

Even if the product did sell well, it seems absurd to try to combine two machines which require a different temperature to do good work, and the several attempts made to introduce it here have as yet been in vain.

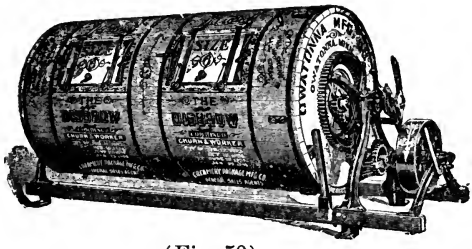
COMBINED CHURNS AND WORKERS.

In this case the temperature desired is about the same and indeed in a warm room the advantage of being able to work the butter without exposing it to the air is considerable. Various constructions have been made. The first I saw (in 1893) was the "Owen," in which the working part was removed, while churn-

ing. This does not seem to have come into use, and later the "Disbrow," the "Wizard," the "Victor," the "Barber's," the "Queen," and the "Perfection," all having fixed rollers, appeared. When there is trouble it is generally because a beginner neglects to follow the directions for use strictly.

The standard churn and the most popular in the West is undoubtedly as yet the *"Disbrow,"* which is illustrated in Fig. 50. The rollers are in the center, while, for instance, in the "Victor," (there are two sets), they are near the periphery of the churn, and in the "Perfection" there is only one roller.

Another construction altogether is the Sharpless "Squeezer." It consists of a revolving drum provided with 6 shelves which are pivoted so that when used as a churn, they are converging to the center of the drum, thus serving as fixed dashers. When working the butter a set of cranks shift their position, squeezing the butter against the drum as it slowly revolves.



(Fig. 50)

(Fig. 51)

The *"Queen"* drum has a corrugated wooden roller on a heavy steel shaft which hangs on a hinged arm in the churn drum provided with narrow shelves.

When churning the roller hangs straight down, while, when working, it is carried up the side of the drum in such a way that the further it is carried, the greater is the distance between the roller and the side of the drum, as illustrated by the manufacturer in a cross-section, Fig. 51. The weight of the roller is sufficient to squeeze the butter. These last two churns do not seem to have gained much foothold. In Fig. 52 I show the manufacturers' cross-section of the "Perfection" drum, it is certainly the simplest of all in construction, but as I have never even seen it work, I cannot give any opinion of it.

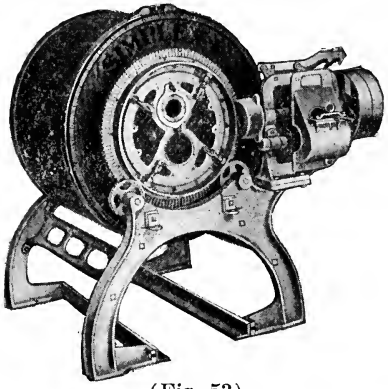
(Fig. 52)

Another candidate for public favor, which is becoming popular, is the *"Simplex"* combined churn which I illustrate closed for churning in Fig. 53, and the removable working gear in Fig. 54. This is an adaptation of old National butterworker and it has the great advantage that the working gear may be removed, cleaned and dried, and that the whole churn is more

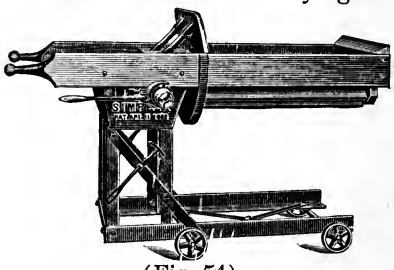
"get-at-able." The condition of the butter may also be observed while working. In Europe there are 8 or 9 imitations of these combined churns, more or less improved and all well built.

HANDLING THE CHURNS.

With a new churn, there is always a danger of the wood imparting a flavor to the first batches of butter. Various ways are taken to prepare it. I have used the following with pretty good success: Soak for 24 hours with cold water, changing it two or three times, churn for half an hour with hot water and some lye soda or other alkali (Unleached wood ashes are very good too). This lye must not be too strong so as to soften the wood. Rinse and churn with hot water. In doing this don't forget to ventilate by opening the cover or the plug a little as otherwise you may have an explosion. Soak with sour milk or buttermilk, rinse with cold water, churn again with alkaline water and finally with hot and cold water.



(Fig. 53)



(Fig. 54)

Just before churning always rinse it with hot and cold water and in cleaning it rinse with cold water, then warm, and finally boiling water, using alkaline water now and then as needed.

Lime water is a splendid thing to use and the small churns may be filled up with it after scalding and left with the small utensils in it to soak up to time of churning. In case of large churns, churn with 3 or 4 bucketfuls for 5 or 10 minutes and draw. There is no need of further rinsing, what little adheres will not hurt the cream. The Danes now whitewash the churns and leave them for a couple of hours, when it is scrubbed off.

In creameries steam should be used instead of boiling water and long enough to make the wood hot enough to dry itself, but combined churns should, according to instructions from the Owatonna Mfg. Co., not be steamed, as it will hurt them.

Covers should be left open and small churns placed in open air to dry unless filled with lime water. A churn continually damp

will soon smell musty and that is the great danger with our large creamery churns compared with the small Danish ones.

Never fill the churn too full, as a rule it is safest to put in less than the manufacturers tell you. End over barrel and box churns should not be filled more than half, but it really depends on the "fall" that is left, that is, if a churn 24 inches deep may be half filled, one only 18 inches should not be filled so full, as that would give the cream a 9-inch instead of a 12-inch drop.

It is always safest to strain the cream into the churn and the coloring should be calculated according to the butter expected. It is easy to keep track of how much milk each vat represents anl use yesterday's yield for an estimate.

Until lately two kinds of butter color have been on the market, the purely vegetable (Annatto) as represented by Chr. Hansen's Danish and Thatcher's, and the aniline or coal tar colors among which Wells & Richardson Co.'s and the Alderney were best known. The latter were free from sediment, strong and cheap, but since the enactment of the Pure Food Law the coal tar colors have been abandoned and Wells & Richardson Co. are now producing a vegetable color. In the minute quantities in which butter color enters into the butter the coal tar colors could hardly be considered dangerous, but since the vegetable colors answer the purpose fully it is better to be on the safe side.

The quality of the oil used as well as the shade and brightness imparted to the butter must be considered in selecting the color.

HAND CHURNING.

Start the churn, and do not forget to ventilate it once or twice during the first minutes and then make sure of the temperature.

After this, strike the right gait (given by the manufacturer), or learned by experience, keep it going steadily—do not get curious and stop to look at it until the regular time has elapsed or the change in the sound warns you that the cream is "broken." If you are musical a song may help you to keep time. If it should not come on time, stop and take the temperature, and if that is wrong correct it by adding hot or cold water. It is also a good plan to take the temperature and regulate if necessary when it is "broken," because if it is too high the butter is apt to retain too much water (16 per cent or more) and Uncle Sam may prosecute you. Then churn again a little slower, but with a steady motion till the granules are of the right size. Some makers prefer them 1-16, others 1-8 of an inch in diameter. I think the latter a little too large and prefer the size between the two.

Sometimes, if the butter does not come, the cream may foam and nearly fill the churn. This may be caused by (1), the cream being too cold (especially if a thin cream), (2), the churn being too full to start with, (3), too high speed being used in

starting, and (4), the milk being delivered from cows just calved (biestings), from strippers or sick cows. Sometimes it will mend itself by allowing the cream to stand quiet for an hour or so, but the safest in the first cases is to divide it into two churnings and start fresh at the right temperature.

DRAWING THE BUTTERMILK AND WASHING.

When the granules are of the right size, and if salt in the buttermilk is not objectionable, the addition of this will make it draw better, but I have seldom been troubled that way, and there is no need of losing a single granule, as a strainer, or better, a hair sieve, should be used in drawing.

When this is done, about the same amount of water of from 50 to 55 deg. should replace the buttermilk (if the granules seem very soft 45 deg. may be allowed); the churn should be turned a few times. Unless it is desired to harden the granules the water should be drawn *at once*. It is a big mistake to leave the butter to soak in water for hours. As a rule two rinsings should be enough and indeed some of the finest butter is made without rinsing at all, relying on the working to remove the buttermilk. The Danes used to do this, but now they rinse the granules by dipping them from the buttermilk with a hair sieve and then moving this gently in a tub of cold water, thus washing the butter only once and only for a minute or so. As in most other matters the best road lies in the middle course.

Too much care cannot be exercised in securing pure water for washing the butter, and I am convinced that in many cases the butter is spoiled by impure water.

If we have deep artesian wells, where no surface water is possible, the water is all right unless indeed it contains too much iron or other *mineral* impurities. Yet it is often customary to pump the water directly into the churn in order to get it as cold as possible, and sometimes this may lead to a most disagreeable result, that is when sand is sucked up with the water, and it happens now and then that a whole churning is spoiled. But with dug wells it would really be best to boil, cool and filter the water used for washing, and I believe it might even pay, at least in large creameries, to distill the water to ensure absolute purity and freedom from germs. If this is too much trouble, at least filter it, and for this purpose the International filter is to be recommended if a smaller size is placed on the market (the one now sold for $110 will filter from 800 to 1,000 gallons per hour). This cure may, however, be worse than the disease if the filter is not kept bacteriogically clean.

Dug wells into which the creamery or stable drainage has a chance to leak should be condemned, and indeed no creamery should be built without first providing the water supply and have it analyzed chemically and bacteriologically even if it costs from $25 to $50.

CHAPTER VII.

SALTING AND WORKING.

Brine Salting is popular with many private dairymen. After draining the buttermilk or after the first washing a strong brine is poured over the granules, the churn revolved, the brine drawn and a fresh lot of brine added. When this is drained, the granules are packed directly into the tub, pail or crock by simply pressing it with the butter ladle. This is a very nice way of selling brine for butterfat and if private customers are satisfied so much the better, but it is not an advisable system selling on the open market, and if the percentage of water left exceeds 16, there is now danger of being heavily fined. First it is difficult to get it salty enough and if this is done by adding some dry salt it is very hard to salt uniformly.

The object of salting is to preserve the butter and improve the taste. This is generally understood, but less so its action in drawing out the buttermilk from the butter granules apparently washed clean. In churning, the microscopical fat globules are joined together into the little visible granules and these contain a great deal of "serum"—buttermilk. The dry salt sprinkled over the drained granules will, in melting, absorb part of the serum, chiefly the milk sugar solution, leaving most of the albuminous matter, and the moisture is thus reduced with less working than is otherwise needed.

APPLYING THE SALT.

Some makers sprinkle half the salt in the churn, revolve it once, sprinkle the other half, and after a while, work it once. In this way it is rather difficult to get uniform results, as it is hard to estimate the amount of moisture and the consequent loss by drainage. Nevertheless, many makers manage to do good work that way and while they use from 1½ to 2 ounces of salt, the butter will only retain from ½ to ¾ ounces—and in this connection we must also consider the solubility of the salt used. If lumpy, the salt should be crushed and sifted.

In Denmark they work the granules very lightly and then weigh the butter, add the salt and work lightly and leave the butter in lumps of 5 to 10 lbs. floating in water at a temperature of 44 to 46 degs.; after 2 to 4 hours they work it the second time. I prefer now simply to weigh the granules and as the weight of the butter is known approximately, a fair idea is given of the moisture and more or less salt may accordingly be added to the granules. After stirring it in with a light touch—the granules should be firm enough to stand this without adhering—leave the salt to dissolve partly for half an hour or so and work it lightly the first time. After 2 to 4 hours work it the second time and there will seldom be complaints of mottled butter.

Indeed I believe it to be a fact that we are getting back from the once fashionable "wash, wash, no working" system to that of the good old "working twice." In creameries this weighing of the granules is impracticable, and, where combined churns are used, impossible, and we must rely on our judgment, controlled by a knowledge of the amount of butterfat in the churn. The trouble is that few makers understand that it is far better to work several times a little at a time than to work once. They forget that the danger of getting salvy butter is greater in the latter case, where the mechanical heat developed by the continuous working makes the butter soft, whereas the butter regains its elasticity if we give it a rest before working it again.

The temperature is all important. If cool the friction, in softening it while working, will make it greasy. If too warm it will not stand working and the moisture will be worked into instead of out of the butter. Between 50 and 60 deg. (according to the composition of the fat) will be found right and creameries should have their worker (as well as churn) in a room which can be kept at that temperature. If the butter is left between workings in a too cold (or too hot) room, say in 60 lb. tubs, there is danger of the outside becoming too firm (or too soft) before the center is cooled enough and the result will be streaky butter. For this reason the Danes prefer to leave it in lumps of 5 to 10 lbs. at that stage.

SALT TO USE.

Years ago good dairy salt was much harder to get than now. Then, indeed, it had to be imported, and "Ashton," "Higgins," and "Luneborg" (used in Denmark) ruled the roost, but now there are several excellent dairy salts made in the States,

notably *"Diamond Crystal," "Worcester," "Cadillac"* and *Colonial"* and a few others. The main thing is never to use coarse, impure salt; by impure I do not refer to chemical purity, which does not always insure it being the best.

But even the very best brand may have been exposed in transit and absorbed odors or black specks may have got into it, so that it is safest to test it by dissolving in water and see if it leaves any sediment or gives a milky solution. Mr. Gurler, in his "American Dairying," recommends dissolving the salt in hot water to detect taints.

As salt absorbs odor it must be stored in a clean place and the careful dairyman will keep an eye on where his dealer keeps it.

We often hear creamery men say: "We use such and such a salt (mentioning a cheap brand) generally, but when we put up butter for cold storage we use so and so (mentioning an expensive salt). How is this? Is it all imagination? If not, why can't they see that if the expensive salts are better for cold storage they are also better for every-day use. There may be good salts among the cheaper brands, but until manufacturers have proven their ability to make them *uniformly* alike, it is safest to use those, year in and year out, which have been proved by years of practical tests.

I confess that I like a salt with a grain to it, so that when sprinkled on the butter it does not mush like fine sugar on berries. I also prefer a salt which does not dissolve too quickly, as I advocate working twice.

Right here there is a common clap trap device used by salt agents when they talk about the special "make-weight" or the clear brine of their brand. A good maker will always study his salt and act accordingly, leaving more or less moisture, according to whether the salt is less or more soluble.

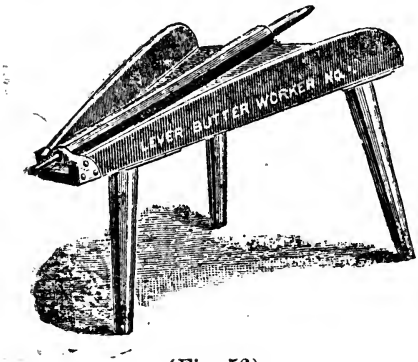
THE WORKERS.

Good butter has been made by working it with the hands and if the dainty dairymaid washes her hands and arms carefully first in hot and then in cold water, there is really no more objection than to the neat housewife kneading her bread or cake, but, to be on the safe side, the watchword is now given: *"Never touch the butter with your hands."*

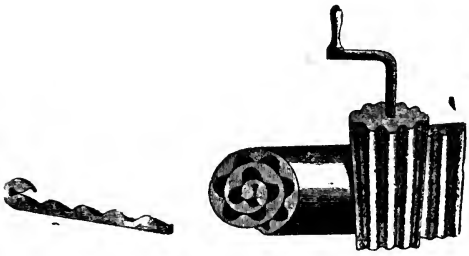
In small quantities butter may be worked manipulating it with two paddles, like Fig. 55, pressing the lump flat in a wooden bowl, and then rolling it up and pressing it endwise, never rub-

bing it, but a small lever worker like Fig. 56 does not cost very much, and if the lever is not rolled or rubber over the butter, but used for pressing it, the result is very satisfactory. Another simple worker not sold here, but easily made, consists of a wide board with two strips of wood on either side and a corrugated roller on a wooden shaft long enough to form handles and two round pieces of wood which keep the roller about half an inch off the board. The roller presses the butter into a flat corrugated piece, which is rolled up with the ladle and turned at a right angle and worked again as shown in Fig. 57. This also represents the way to work butter on the rotary worker, which is illustrated by the *"Embree"* (58) and one of the latest European modifications made by Konstantin, Hansen & Schroeder, of Kolding, Denmark, (Fig. 59). The one mostly used in the western creameries before the advent of the combined churns and workers, was the *"Mason,"* but it was not nearly as good as either of those illustrated. Similar workers are made by the various manufacturers and have kept their ground in spite of hundreds of modifications which found favor as labor savers for a short time. In buying these workers in which the table revolves one way and the rollers the other it is necessary that their surface speed correspond exactly, if not, there will be a rubbing motion, making the butter greasy.

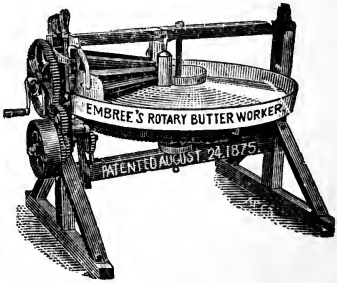
(Fig. 55)



(Fig. 56)

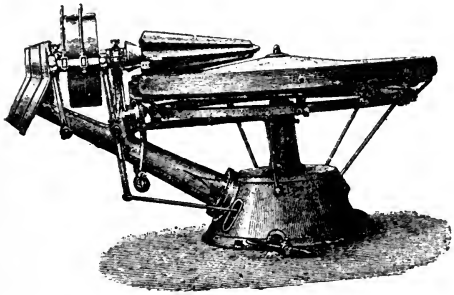


(Fig. 57)



(Fig. 58)

To describe when butter is worked enough is next to impossible. There should not be more than between 12 and 14 per cent. water left; when a piece is broken it should show a granular construction like coarse cast iron, and when pressed with the ladle a few drops of clear brine should show. This is the nearest I can get, but experience will soon teach and the object is to avoid too much moisture on one side—selling water for butter—(the legal limit is now 16 per cent. in America, England, Germany and other countries)—and too little on the other side making the butter difficult to spread and losing weight.



(Fig. 59)

USING COMBINED CHURNS AND WORKERS.

The popularity gained by these in our western creameries and lately also in the East and even in conservative Europe, is undeniable and the reasons are evident. (1.) Saving of labor in removing the butter from churn to worker. (2.) As most creameries are not provided with a special fly-proof room where the right temperature can be maintained, the keeping of the butter shut up in the churn and worker until ready to pack is an evident advantage. (3.) The saving of space is another great advantage.

Objections have been raised (1) that they are difficult to clean; (2) that it is very difficult to get the salt evenly distributed and hence there is a liability to mottles; (3) that the butter would retain too much moisture; (4) that the maker cannot watch it to remove specks if there are any, nor stop just at the right moment; (5) that some of the constructions would grease up several pounds of butter at each end of the inside gearing; (6) that they are expensive, and unless renewed often would be impossible to keep sweet.

I have but little practical experience with these churns, and did not at first encourage their introduction, preferring to preach the providing of churn and working room so that the only advantage remaining would be that of saving labor and space.

On the other hand a close observation of the ways in which

it has been used by some of our best makers and the resultant butter has convinced me that most of the objections must be negatived. (1.) If they are treated as suggested for the other churns they *can* be kept sweet, at least as long as age has not made the wood too soft. (2.) By adding the salt (sifting it so as to have no lumps) carefully, distributing it evenly and letting the churn revolve a few times at the slow speed before setting the rollers going, an even salting can be secured, though a little more salt may be consumed. (3.) By having the granules of the *right temperature* and by working the butter twice or three times, the moisture *can* be sufficiently expelled, especially if it is given 10 or 15 minutes for every 6 or 7 revolutions and allowed to drain. If necessary the temperature may be lowered between workings by placing some blocks of ice on the rollers. A late patent calls for the shelves slanting in opposite directions whereby it is claimed the butter is mixed better and the salting done more evenly. (?) (4.) Practice will soon teach the maker to stop in time, and if churn, cream and salt are clean, there can be no specks or flies to remove. (5.) This is true to a greater or lesser extent, but when 500 or 900 lbs. are worked at once the loss is not great if care is taken not to pack the greasy butter with the rest. The shelves should also be watched so that no lumps of butter remain permanently there (escaping salting), as, if incorporated later on, they will produce mottles. (6.) They may become expensive if renewed often, but that is a small matter compared with the saving of labor. While personally I am perhaps too much of an "old fogy" to adopt the new system in a small creamery, it would be unfair not to acknowledge that with careful work virtually all objections must be dropped while the advantages remain, and in a large creamery they are absolutely to be recommended.

"THE OVERRUN."

The "Overrun" is the difference in the weight of the butterfat found by the test in milk (or cream) and that of the marketable butter made.

Butter is composed of fat, water, salt and casein. The proportion of these elements may vary considerably, even without the conscious intention of the maker.

The average composition of American butter has been placed as being 83 per cent. fat, 13 per cent. water, 1 per cent. casein and 3 per cent. salt. The analysis of eight hundred and two

samples of show butter varied in water from 7.2 per cent. to 17.6 per cent., with an average of 11.78 water.

Danish butter averages about 14.25 per cent. water with a tendency to a slight increase.

It will thus be seen that the "overrun" may vary nearly 10 per cent. simply by incorporating more or less water in the butter. Casein may vary from 0.5 per cent. to 2 per cent. and salt, of course, from nothing to 2.5 per cent. or 3 per cent., exceptionally more.

But in addition to this cause in variation, the butterfat lost in separation, in handling milk and cream and in churning, may make considerable difference. Let us say that, with milk testing 3.8 per cent. fat, the loss in skim milk is 0.1 per cent., and that we take about 11 per cent. cream and lose in handling it and in churning 0.4 per cent. Let us further say that we make a butter containing 83 per cent. fat, then we have an "overrun" of 16 per cent.

But if we lose 0.2% in the skim milk and 0.8% in the buttermilk and handling the cream and the butter still contains 83% fat, then the "overrun" will only be 11%.

Nor is this variation anything extraordinary in practical every-day creamery work, and it shows the value of a good buttermaker, who, by careful work, day in, day out, may easily save the patrons, say 3 per cent., in this way and another 3 per cent. by incorporating just about the right amount of water. This will, in a creamery with 10,000 lbs. of milk per day, amount to 26 lbs. of butter per day, or at least $5.00, and yet many patrons will hesitate about paying him a monthly salary of $100.00 or $125.00.

CONTROLLING THE WATER PERCENTAGE.

The above shows the importance of being able to control the percentage of moisture in butter from a financial standpoint, but there is also a moral reason, as it is evidently dishonest to incorporate too much water and sell as butter and finally there is *now* the legal reason as our National government (and other countries) have established a *maximum* standard of 16 per cent. water, and if we exceed that the butter will be deemed *adulterated* and the maker fined heavily. While I have nothing to say against the buttermakers trying to put in a reasonable amount of water, say 14 per cent., I cannot too strongly warn them to be very careful in going too close to the margin, as we have—as far as I know—no rules whereby we can absolutely control the water

contents within 2 per cent. The makers who want to be on the safe side should test the butter before taking it from the churn and use one of the moisture tests on the market. In most cases the samples taken from the churn will show not quite one per cent. more water than when taken from the packed tubs and so 15 per cent. may be deemed fairly safe, but not absolutely so. If tub samples are taken it should be more than one from each churning. The great mistake is to look upon 16 per cent. as the ideal *standard* instead of the *criminal limit,* which it really is. In a creamery where the buttermaker has complete control of temperatures and does not aim to have more than 14 per cent. water there is but little danger of conflicting with "Uncle Sam."

Before discussing this question further I must draw attention to the old, old fraud, which reappears under new names. An enormous increase in the butter yield is secured by addition of rennet, or similar stuff, which coagulates the casein, and this, with or without the addition of extra melted butter, is incorporated with the butterfat, making what might possibly be called a very rich cream cheese, but which has no right to the name of butter. Fifteen years ago it was pushed under the name of "Guiness" process butter, and a large creamery was run in Chicago which was used as a decoy to sell county rights. Later "Black Pepsin" was advertised for the same purpose, and now I notice that it is sold as "Richards Butter Rennet." As soon as the papers get onto the fraud the name is changed, and, no doubt, it will appear under a new name again and again.

Remember, if 100 lbs. of milk contains 4 lbs. of fat and you do your very best with the best modern implements, you can never make more than 4.6 to 4.7 lbs. honest butter, and never hope to fool any buyer with much more than 5 lbs., be the increase obtained with water or casein.

The elements which influence the amount of water in butter lie chiefly in churning and working. If we churn at a too high temperature and churn too long or even simply so as to get large granules, we increase the moisture; or, if we churn at a low temperature and use warm wash water and overchurn it, then we will increase the moisture. Even so in working, if it is done at a too high temperature we work the moisture in instead of out. If we drain the granules carefully before adding the salt, the salt will, in dissolving, draw moisture from the granules and help to reduce the moisture.

Assuming the churning to be normal, then it may be said that we best regulate the moisture by raising or lowering the temperature of the wash water, which means the initial temperature of the working, and by draining the granules more or less before adding salt.

It is true Prof. Storch claims another influence on the moisture contents of butter—cream ripening—but I have not been able to understand it or to find any confirmation in practical work.

The overrun is influenced by cream ripening only in so far that it may influence the churnability of the cream and leave more or less fat in the buttermilk.

There is, I regret to say, a tendency nowadays to lay too much stress on the overrun—*the quantity*—to the neglect of ***the quality.***

CHAPTER VIII.

PACKAGES AND PACKING.

FOR THE PRIVATE DAIRY.

For the dairies the Bradley Boxes (Fig. 60), holding 2, 3. 4, 5 and 10 lbs. and packed in crates (Fig. 61) are used a great deal, as well as the bail boxes (Fig. 62), holding 5, 7½, 9 and 10 lbs. They are very good and practical packages, accepted by the trade, the latter chiefly in the West.

One pound rectangular prints wrapped in parchment paper and sent in return boxes provided with an ice chamber (Fig. 63) is very popular in the East, and (packed solid) is fast gaining ground in the West. Indeed prints put up in cartons under some special brand are being pushed by many creameries and dealers and the sales, both East and West, have increased enormously. With the return boxes the difficulty is to keep the trays perfectly sweet, but this trouble may be overlooked when a good price is secured. If packed solid the 54-lb. cubical or 50-lb. rectangular box is mostly used. There are numerous other packages, such as the "Record" tin lined package, the "Crystal," a glass jar in a galvanized pail, paper boxes round (the "Gem") and square, etc., etc., not to forget the old stone jars, but these are not popular among the men who handle the butter in the large markets and should be used only for local trade or for private customers. Round and square prints are also suitable and are

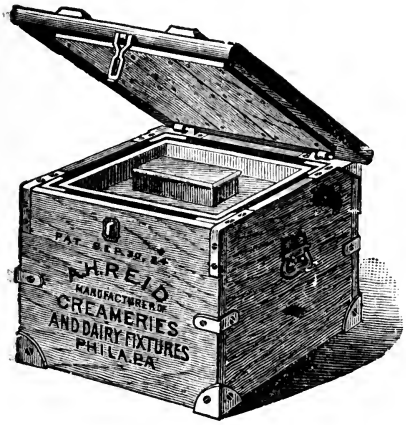
(Fig. 62)

(Fig. 60)

(Fig. 61)

made with the hand moulds similar to the one shown in Fig. 64. They should be wrapped in parchment paper or *new* muslin, never in the cabbage leaves or linen cloths of suspicious origin.

In printing it is also important to be sure that there is full weight and whatever printer is used, the weight should be tried now and then, even if each lump is not weighed before printing. A neat scale for this purpose is made with a porcelain plate. The parchment should be soaked in brine.



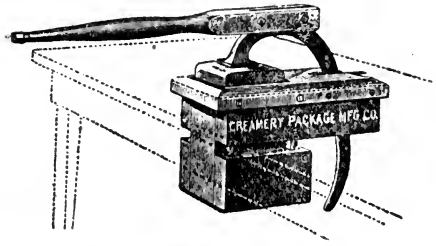
(Fig. 63)

(Fig. 64)

(Fig. 65.)

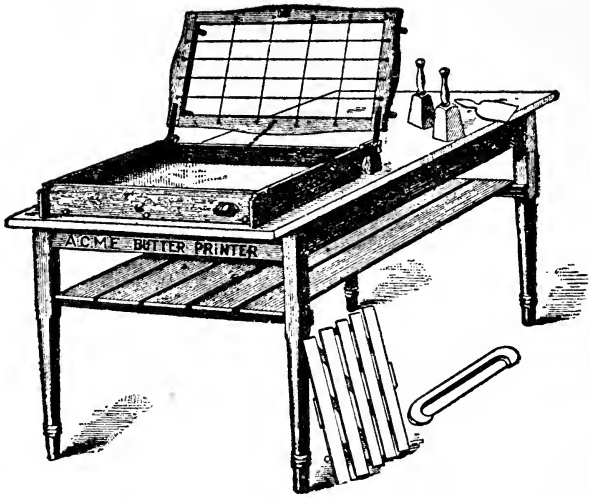
FOR CREAMERIES AND LARGE DAIRIES.

When more work is desired we have a great many devices—the "Nesbit," the "Rapps Automatic," the "I. X. L.," etc. Some of the most popular ones of this class—"single" printers—being those similar to the "Lafayette," shown in Fig. 66, or the "Eureka" in Fig. 65. The former is fixed on a table (indicated in dotted lines) and with a little practice very fast work can be done with either.

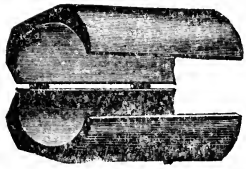


THE LAFAYETTE BUTTER PRINTER.
(Fig. 66)

Quite another system is illustrated in Fig. 68, the "Acme," originally called the "Lusted," in which 25 1-lb. or 50 ½-lb. prints



(Fig. 68)



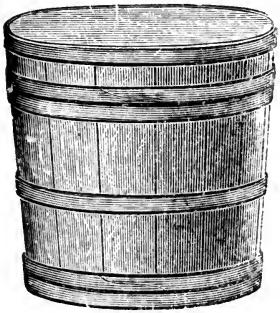
(Fig. 69)

(Fig. 70)

are made at one impression. This system has gained ground and been modified and improved by various manufacturers. Special devices for cutting up tub and box butter into prints are also made, notably, by the American Butter Cutting Machine Co., which has a great variety, and the Low Butter Cutter Co. also makes one. A new machine has recently been put on the market for wrapping the prints. It is power driven and has a claimed capacity of 40 a minute. It is said to give good satisfaction. Finally in Fig. 69, I illustrate the mold used for the California two-pound roll, the standard size in that market. Larger private dairies sending to the open market may safely use 10, 20, 30, 40 and 60 lbs. tubs, same as the creameries.

Creameries in Europe nearly all use the Danish 56 and 112 lb. beech firkin (Fig. 70) though in some countries the heavier oak

may be seen. In America the standard creamery package is the 60-lb. tub (Fig. 71), made of white ash, with five black ash hoops. Indeed, so wedded is the trade to this package that any divergency, even the least, may cause a reduction in price. Thus it would be nearly impossible to sell Elgin butter at the market price even in ash tubs, if there were six hoops on them. Nor is this kind of prejudice altogether without a reasonable explanation, as the six-hoop tubs had been used largely by gathered cream creameries, and hence Elgin butter would at once be suspected of being such, and each tub would have to be examined as to quality. Nor would it look well in a carload to have some five hoop tubs and some with six hoops.



(Fig. 71)

These tubs are made in sizes to hold 10, 20, 25, 30, 40, 56 and 60 lbs., the latter being the one most used by creameries. A handmade tub is generally preferred, and though the machine made (staves tongued and grooved) are neater in appearance, they are not nearly so popular. The New York oak tubs are hooped with galvanized iron hoops, but seldom seen now.

Boston will take spruce tubs, but they are not very popular in the other large markets, they look very neat indeed when new, but do not come out of cold storage in good shape. The tub covers are fastened with various fasteners, but the trade endorses only the tin straps fastened with half-inch wire nails, and the various patent hooks sold should not be used.

(Fig. 72)

For export to England neat oak 110-lb. firkins used to be the package, but now the Australian square box is the standard.

It is made of poplar and spruce and measures inside 12x12x12 inches and exactly 56 lbs. should be packed in it, or rather a little more, so as to make it hold that on arrival in England, no more, no less. The English trade custom demands this and will not pay for

any overweight, while underweight will cause no end of trouble. Various boxes have been made with grooves in the wood and with slats nailed on so as to secure air circulation between the boxes when cold stored.

For export to South America and other warm climes tin cans carefully soldered and packed in boxes with rice shells or dry saw dust are the best.

Wooden packages should be kept in a clean, dry place, a damp storeroom may cause moldy tubs.

PREPARING THE PACKAGE.

Stone and glass jars as well as tin cans need of course only to be *clean* in a "dairyological," not to say bacteriological sense, but wooden packages require more than this. Tubs and pails strong enough to stand it should be scrubbed inside with hot water or steamed and then soaked for 12 hours with cold water or weak brine and again scrubbed with fresh cold water or brine just before using. The water should be as pure as that used for washing the butter. The outside should be kept as dry as possible. If thoroughly steamed and then rubbed with salt it is said that 2 hours soaking is all sufficient.

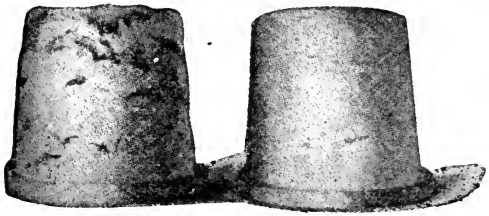
The use of parchment paper lining is now quite general. In tubs only the bottom and side should be lined and the very best paper soaked in strong brine for a few, if not 12, hours should be used, and the tub should *always* be prepared as described above, as otherwise mold may appear.

I confess to a partiality for the system of steaming the tub in a steambox and then at once give it a coating of paraffine. I believe there is less danger of mold, and certainly less soakage of brine into the wood, but properly prepared parchment paper should also be used. In Fig. 72 I show the Capper Paraffiner where, after steaming the tub, the paraffine is forced in by steam pressure. I refer also to U. S. Bureau of Animal Industry cir. cular 130 describing an apparatus where it is forced in by a hand pump. It may, however, be done by applying it with a brush provided the tub and the paraffine are hot enough.

PACKING.

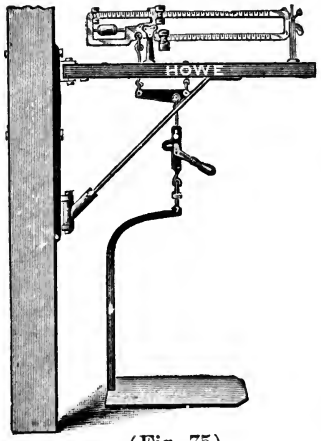
Packing should be done while the butter is pliable and by pressing with a ladle or (in tubs) ramming with a "packer" (one kind may be seen in Fig. 70). Too much should not be put in the tubs—never more than 5 to 10 lbs. at a time, and

each lot should be carefully rammed so as to get it solid and leave no air spaces. To do this, use the packer with a slight slant from the center to the sides of the tub. This is all important, not only in order to exclude the air (which reduces the keeping quality), but also because it is foolish to pack four to five pounds less in a tub than it will hold, as was done in the tub shown in Fig. 73. The New York *Produce Review* kindly lent me this illustration from an article on packing, one of the many interesting ones published by that enterprising paper. In Fig. 74 is shown a tub packed in a nearly perfect manner, though there is one place defective.



(Fig. 73) (Fig. 74)

Ram the butter so as to more than fill the tub and strike it off level with the edge. Some use a wire to cut it with. If you want to smooth it do it by pressing with the ladle, not by rubbing, which makes the butter greasy. Line bottom and sides with good parchment paper, leaving an even edge of about one inch, to be folded neatly over the top before putting on the cloth circle, then dampen this with brine and sprinkle a thin layer of salt on top of it. Fasten the cover with 4 equidistant tin straps, using half-inch wire nails. Stencil uniformly without getting finger marks on tub, weigh the tub before filling and after, marking the gross and tare in pencil. Reweigh the day of shipping and you may save yourself from being unjust to your commission man. If the butter has not too much water, if the tub has been properly soaked, if you allow ¼ lb. to ½ lb. per 60 lb. tub for shrinkage, and if your scales are correct, you need not fear any deductions from your weights by honest commission men. In this connection it must be said that scales, especially platform scales, are liable to get out of order, brine will soon rust them; hence one similar to the one shown



(Fig. 75)

in Fig. 75 is preferable for weighing butter, and all scales in a creamery should be frequently tested and kept scrupulously clean.

SHIPPING AND MARKETING.

In the open market dealers prefer to have no private stencil or trade mark on the package, and especially do they object to the name and address. If you use these and your butter is not up to the standard, leave them off, and, in any case, always notify your receiver if for some reason a shipment or part of one is not as good as usual.

Too much stress cannot be laid on keeping the packages clean and protected from heat and dust in hauling to market or to the railway, and while waiting for the train. Too often have I seen tubs exposed for hours to the sun on the station platform, and if the creamery man cannot attend to it himself he ought to arrange with the agent to have the tubs protected and not soiled in loading.

Never contract your butter for a whole year at the quotations of a certain market. Whenever a large number of creameries do that, it is a temptation for the buyer to manipulate that market. Indeed, some of the Boards of Trade become more or less of a farce, when less than one-tenth of the butter from the members is put up and sold on the open board. If you sell at all, sell at a fixed price.

Never ship a "sample shipment to an unknown house" which offers to buy it at a cent or two above the market. If they do not fleece you the first time, they will do so when they get a large shipment. They often send circulars giving well-known names as references without authority.

Never try to pit two commission houses in the same city against each other by dividing a shipment, especially if you use your own stencil.

If you have a good commission house, stick to it so as to give it a chance to work up a trade on your butter.

Always insist on a prompt account of sale and remittance. The lack of this shows either lack of good business system, or a desire to run their business with your money.

Instead of getting offended when your commission house draws your attention to some fault in your butter, insist on

it doing so; follow its advice closely as to the amount and quality of salt, color and style of package.

Selling direct to consumers is another matter, and is to be advised, as a rule, only in case the producer can comfortably deliver it once a week from his own wagon. The price should then be fixed, say for each month, or at least for the six summer and the six winter months. To contract at a uniform price for the year is not advisable, as in most cases the consumer will be willing enough to take the regular quantity in winter; but in summer, when he can buy it elsewhere for six to eight cents less, there is danger of trouble. In this case it is also wise to remember that "short accounts make long friendships," and make the collections regularly at least once a month and better once a week.

To sell direct to consumers, who live at a distance, is less satisfactory, as there often is occasion for misunderstanding; yet it can be done in exceptional cases with great profit, and for this kind of trade some of the different fancy packages may be used with advantage, though as a general proposition I cannot endorse any *return* package. But, in selling direct it is well to remember the extra cost, trouble and risk incurred, and in order to do as well as selling the whole make for cash to a dealer or through a commission house, it is certainly necessary to get at least five cents more a pound at the creamery.

THE FUTURE BUTTER AUCTIONS.

The greatest defect in our present system of marketing is the lack of an equitable payment according to quality. It is true some of our dealers have made an attempt to introduce it, but I have no faith in it until a comprehensive general system is adopted.

We are not yet ready for such a system, which is simply an extension of co-operation, but I shall shortly refer to it here. Let us assume that 400 Minnesota co-operative creameries or, if you please, 1,000 Minnesota, Iowa and Wisconsin co-operative creameries join together in a "Northwestern Butter Auction Association." They hire or build cold storage room in Chicago or New York, as may be deemed best, and secure the services of a competent and honest manager.

Shipments are arranged so that a regular number of tubs (or nearly so) arrive each day and these are then graded by

well-paid expert judges, who must not be interested in the buying or selling of butter; each lot is then sold, according to grade, by auction, after having been branded with a registered trademark. Returns are made in a daily printed bulletin, so that the makers will know the result promptly. No need to go into detail here. The system is as old as the Cork butter market and is also used by some of the German creamery associations.

CO-OPERATION.

I cannot, in this connection, refrain from urging an earnest consideration of extended co-operation among the farmers. It is my conviction that only in this way can the farmers save themselves from being fleeced both in selling their products and buying supplies and implements.

We should aim to educate ourselves on that line and follow the example of Denmark and Belgium, where co-operative stores, co-operative egg collecting and export, co-operative selling and buying of seeds, fertilizers, fuel and whatnot, co-operative insurance and co-operative slaughterhouses obtain.

CHAPTER IX.

ICE HOUSE AND REFRIGERATORS.

EVERYBODY OUGHT TO PUT UP ICE.

Even though ice is not as important in these days of separators, no buttermaker, be it on the farm or in the creamery, ought to be without a stock of ice or snow, so as to have complete control of temperature. Nor can the value of ice to the farmer's wife and family be overestimated, and whenever the winter is cold enough it is not a very great job for a few neighbors to join together and scoop out a pond if no river or lake is within reasonable distance. Even if such pond ice is not fit to use in cream directly, it will cool as well as the best, and if there is plenty of snow, and it is packed solid by wetting it a little and trampling it, about the same cooling effect can be obtained from a cubic foot as from ice.

It makes a difference only of about 5 per cent whether ice is gathered in thawing or freezing weather, but in stacking it is important to pack as solid as possible and fill the spaces with crushed ice.

THE ICE HOUSE.

The cost of an ice house need not prevent any one from having one. I have preserved ice by stacking it on a two-foot layer of sawdust and covering it in the same manner. I even left a small chamber in the center of the pile, the entrance being protected by two feet of straw packed between boards. There I could keep meat fresh for a week or more. Such an ice vault should not be opened more than two or three times a week, as otherwise the ice will melt too fast.

This is not the best way and houses may be built to suit each one's purse. In this, as in other matters, co-operation between three or four neighbors is the thing.

If the floor is absolutely tight and laid on a layer of saw-

dust, that is the best, but it will do very well to pile it on a thick layer of sawdust or even straw provided good drainage is secured. (Not necessarily direct drainage, but, for instance, a layer of gravel.)

The walls (both inner and outer) should, to get the best result, be made of matched boards and be two feet apart and this space should be filled with closely packed insulating material. The inner wall *may* be dispensed with and the insulating done as the ice is piled up, but this will waste more material.

Such a wall filled with dry sawdust or chaff will stop the air circulation even better than a whole lot of board and paper partitions and will, as a rule, be much cheaper in the country. A series of air spaces allows circulation in each and unless there are many of them the insulation will not be perfect, but they are cleaner and not so apt to get damp and musty as the solid sawdust or chaff which every few years must be taken out and dried.

A combination of the two systems might possibly be the best; say 12 or 18 inches solid in the center and an inch air space on either side.

The floor should slant toward the center so that the ice will lean that way and not, in melting, press on the walls. It is enough to cover the ice with a foot or so of the insulating material, but above this free circulation of the air should be allowed. If exposed to the sun it is a good thing to have a sort of tent roof above the regular roof so as to provide shade.

The value of various insulating material may be ranked in the following order: cotton, husks of barley, wheat or oats, leaves, chaff, husks of rice, wheat straw, sawdust and peat, all losing value if not dry.

Chaff, leaves and husks should not be used under the ice in the bottom, as, when damp, they easily ferment and develop heat.

As to the unavoidable loss during the year by melting in the ice house, it is estimated that in December it amounts to about 45 lbs. for every square foot of the inside surface and hence the percentage of loss is much greater in a small ice house than in a larger one.

Refrigerating machines have been hinted at before and where a new creamery is built and where ice can not be secured virtually at the door of the creamery, a refrigerating ma-

chine seems to me to be advisable, but we must be prepared to spend at least $1,000 on it, as a too small machine is a delusion and a snare. We should have a brine tank in the cold storage room to hold the temperature during the night. There are various systems in the market, but for creamery use it seems the direct expansion ammonia system is the best, providing the coiling is done by experts so that there shall be no leakage.

Liquid air has not yet been made practicable.

REFRIGERATORS.

Small double boxes may be constructed on the farm with from 2 to 4 inches thickness of felting or 6 inches sawdust, and will do nicely, though refrigerators can now be bought at reasonable prices.

Refrigerating rooms, like good ice houses, may be built either way, but, as a rule, the air space system is the simpler and is effective enough if there are at least five air spaces, and if all circulation of air from wall to ceiling and floor and from wall to wall is effectually stopped. Careless builders often make the partition a delusion and a snare by knocking holes in the paper when putting it up. The studs are placed at a distance that will allow the paper to lap over an inch or so and a 1 inch thick strip is then nailed firmly over the seam on the studs, the next paper put on, and so on until from 5 to 7 air spaces are built up. The inner and outer walls are made of matched boarding. The paper should be close and air-tight and should not swell. Prof. King recommends the 3-ply giant paper made by the Standard Paper Company, this is acid proof. The wood used should not have a strong smell, like pine.

The biggest danger is at the joining of walls, ceiling and floor. It is safest to fill the lower six inches of the air spaces with mineral wool, as it must be remembered that a leakage of air at the bottom is far more detrimental than at the top. The floor should be insulated as carefully as the sides and should be water tight.

The door is a difficult problem and requires a good carpenter to construct it so as to fit tight and yet not swell and stick too hard. It is always better to have a sort of entry room, or at least two doors so far apart that one may be shut before the other opens. Good doors with frames may be bought ready made.

It will be seen that even a refrigerator may be constructed

cheaply, but in creameries it is well to employ an expert and secure perfection, as the danger from mould, not to speak of waste of ice, is considerable.

Suffice it here to draw attention to a few more points. The ice shelf or chamber or the refrigerator coils should be placed near the ceiling and insulated so that no moisture will condense underneath and drop on the floor, but be condensed on the ice and be removed with the water from the ice tray through a pipe with a water lock.

Circulation should be insured by a partition or false wall and ceiling, which, if there is only one ice shelf, should extend nearly to the floor on one side and to the opposite end of the ceiling at the other side. If there is an ice shelf at both sides it should nearly reach the floor on either side and extend from both to nearly the center of the ceiling. In the latter case the hot air will pass up in the center over the ice which dries and purifies it, letting the cold air drop down at both ends of the room.

The very best insulation, even if expensive, has been to fill the space with mineral wool. Prof. Robertson says that 100 lbs. will pack about 20 square feet of space six inches wide. Lately the Nonpareil cork board has been put on the market in sheets from 1 to 3 inches thick, which is said to be satisfactory when finished with a cement coating, and should be investigated before choosing insulating material.

JENSEN CREAMERY MACHINERY CO., INC.

CHAPTER X.

PASTEURIZATION FOR BUTTERMAKING.

NOT THE SAME AS FOR CITY USE.

When pasteurizing for buttermaking it is not necessary to keep the milk or cream at the temperature of 160 deg. for twenty, or even five minutes, unless indeed it be intended to hold the cream for a day or more or ship it a long distance before setting the cream for ripening, in which case the keeping of it hot for a longer period may be desirable.

And this is easily explained. If the heated and re-cooled cream is inoculated, *at once,* with a good "starter" these good flavor bacteria (or ferments) get a start of the few possible bad germs that may have survived the short heating. In any case it must be remembered that only "*sterilization*" or heating to 215 deg. can give us absolute security and that this temperature is incompatible with fine butter.

On a large scale, in a creamery, the short time heating, which allows the use of a continuous heater, is the only practical one.

ON THE DAIRY FARM.

For buttermaking on the dairy farm I can hardly imagine any condition that would make pasteurization desirable as a regular practice for buttermaking, and yet there might be cases (where weeds may taint the milk), when it should be tried as a remedy. Or, when very small quantities of cream make churning once a week desirable, pasteurization may be resorted to. Even so may it be used as a temporary relief until you discover the cause of "slimy" or "ropy" milk, which is generally due to lack of cleanliness somewhere.

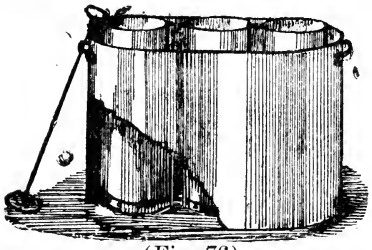
It is true pasteurization will *not* cure milk of a very strong, leeky flavor, but it will reduce that and remove many minor taints.

In the gathered cream system where there is no ice or very cold water at command, or where it is desired to keep the cream

for gathering only twice a week, I have a good deal of faith in the future application of this system of preservation.

But, once and for all, understand that pasteurization is no panacea for all evils nor any excuse for lack of cleanliness. Indeed, it requires a high standard of cleanliness if it is not to turn out a delusion and a snare.

Any *clean* tin can, free from rust, preferably of a similar shape to the shot-gun can, will do. A stirrer made of smooth, clean hardwood, but preferably a tinned iron rod with a little dasher, and a boiler of suitable size completes the outfit required. Fig. 76 shows such a boiler for three regular shot-gun cans with the stirrer to the left.



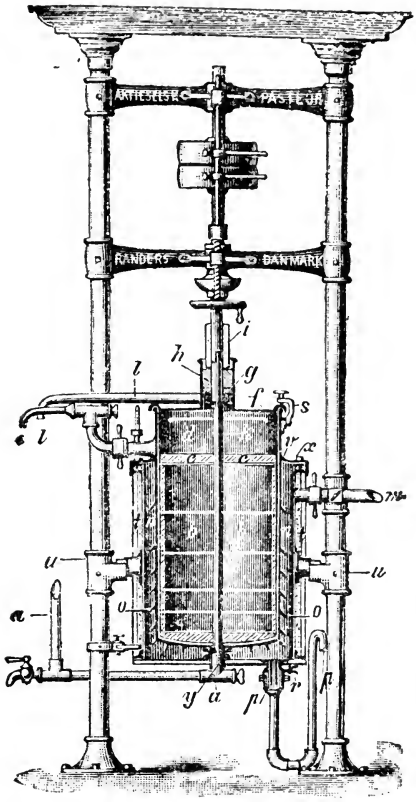
(Fig. 76)

Place the boiler over the fire and when the water is about 120 deg. set the can with the cream in the water and stir continuously until the cream is 160 deg., remove the cream can, reduce the temperature of the water in the boiler to 165 or 170 (if warmer) by adding cold water, replace the cream can with the cover on and keep the boiler where the water will not drop below 160 deg. Another way to maintain the temperature is to have an insulated box as mentioned in the chapter about starters and to place the cream can there. Keep the temperature for 20 or 30 minutes and remove the can for cooling, or, if you want to make butter soon, cool it at once to 70 or 75 deg. and add the starter.

If the cream is to be shipped a quick intensive cooling is desirable, if cooked flavor is to be avoided, and for this reason we must either have something like the Champion or Star cooler, or else have a can or tub with ice water in which to plunge the cream can and cool quickly to 40 or below by stirring the cream with one hand and the water with the other. Thus the keeping quality of the cream will be greatly increased and this practice is commended to patrons of gathered cream creameries. But if we have no ice and cannot cool to 40 degs. I prefer to cool only to 60 degs. rather than any intermediate degree, as 60 degs. is less apt to develop bad flavors.

IN THE CREAMERIES.

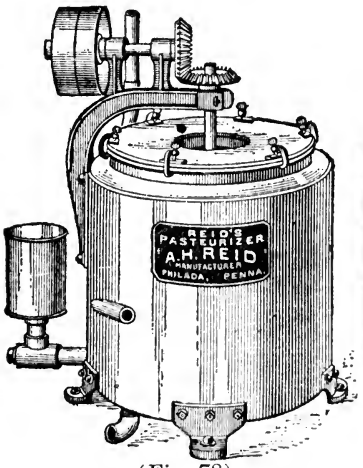
The first pasteurizing heaters used were those devised by



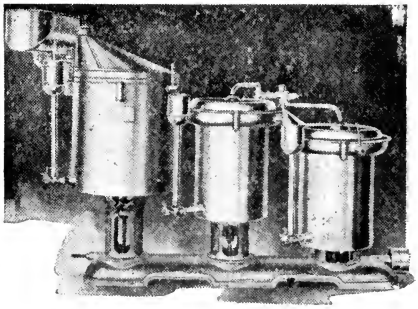
(Fig. 77)

the late Prof. Fjord, of Denmark, mentioned in the chapter on heating milk for separation (See Fig. 28). These have been greatly improved by the government experts of that country. In Fig. 77 I illustrate one of these modern Danish heaters. It is hung on pivots *u* on a neat iron frame screwed on to the floor and ceiling. The steam is let into the well insulated jacket *n* from the pipe *m*, which is easily desconnected by a union. The condensed water leaves through the waterlock, having an air cock. *r*. The tinned copper cylinder *v* is provided with drip-rings or flanges *o o*, and the dasher *c* with foam-killing plates. The milk enters at *a* and leaves through the lower opening *e* and what little foam which is not destroyed in the room *d k* leaves by *l*.

On this side of the water, the one made by A. H. Reid (Fig. 78) and also the one made by Jensen Mfg. Co. represent this type. Of other heaters I refer to



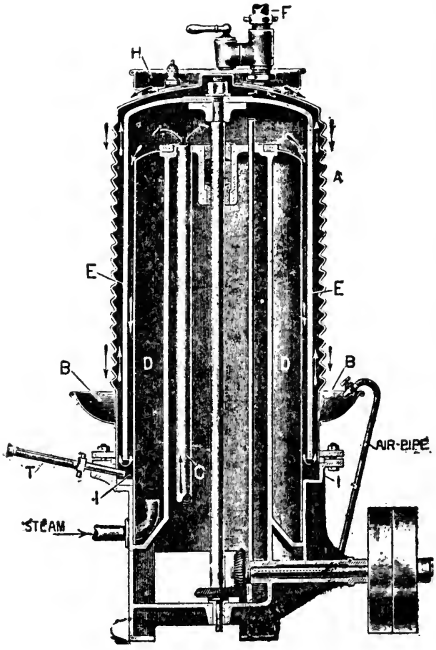
(Fig. 78)



(Fig. 79)

the "20th Century" (See Fig. 30), which is sold as a pasteurizer under the name of "Farrington," having cooling disks in another compartment, while the "Miller," which I show with cooler attached in Fig. 79, and the "Sturges & Burn" differ in using hot water instead of steam, and in having the milk flow between two revolving heating surfaces. Then we have the "regenerative" heaters of which the Ahlborn is considered the best up-to-date. The "regenerative" action is, that the cold milk cools the hot while the hot milk heats the cold, and the great saving in heating and cooling material (coal and ice) is thus evident.

In Fig. 80 I show a cross-section of the apparatus. The cold milk runs into the upper circular receptacle H on top of the pasteurizer and flows over the corrugated mantel A; here it is heated by the warm milk inside the mantel and is caught in the annular trough B and led into a small tank, not shown in cut. This tank is connected with one of the most "sanitary" pumps I ever saw and the milk is forced through the pipe C to the top of the inner chamber in the pasteurizer flowing over the steam chamber D down the inner side of the rotating cylinder E and up between its outside and the inner side of the corrugated mantel A.



(Fig. 80)

A thermometer T is placed at the point where the milk has its maximum heat. The milk is then discharged to the cooler through the pipe F. It is evident that the milk when it leaves the apparatus must have equalized, or nearly so, the temperature of the cold and hot milk, or to give an example, if the hot milk at T is 160 degs. and the cold milk at H is 50 degs., then the milk at E will be about 105 degs. or just about right for running through the separator.

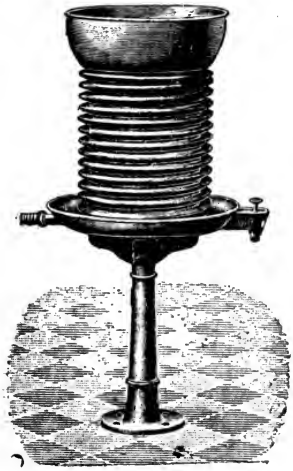
The Miller people and D. H. Burrell & Co. now also make regenerative pasteurizers.

Personally, I prefer to heat the skim-milk and the cream separately. I have found that when the new milk showed an acidity of 14 cc by Mann's Test, the cream would only show 9 or 10 cc, partly on account of the greater proportion of fat and partly, I presume, because many acid producing bacteria are sent to the wall of the separator in the slime, and partly because there is less serum in proportion to the fat.

But another reason is that at but few creameries can we afford to cool the skim-milk properly, and hence, I deem it better not to do it partially, but rather return the skim-milk real hot, hot enough to pasteurize the little milk left in the cans.

Prof. Farrington draws the line of 0.2 per cent acidity, or about 11 cc by Mann's Test for pasteurizing for commercial purposes, and I feel inclined to draw a line not far from that even for buttermaking. It is a fact to be remembered that all heaters hitherto used will coat (and thus lose efficiency) just in proportion to the acidity of the milk and that the cooked flavor also increases with the original acidity.

Whatever system is used, a quick and *intense cooling* is absolutely necessary if a cooked flavor is to be avoided. For this purpose, the "Star," (Fig. 3), the "DeLaval" or the "Smith" Cooler (Fig. 81), are all efficient and good. And so are the direct expansion coils or brine coolers, used in connection with refrigerator machinery.



(Fig. 81)

But all these coolers require a considerable drop, and if this is to be avoided, I know of no better coolers than the improved "Baer," shown in Fig. 34, and arranged zig-zag, one under the other. These coolers may be made any length and three 10 feet lengths will only require a total drop of 1 foot, and the first heat can be taken out by using the condensing water from the refrigerator (say at about 78 or 80 deg.) in the first length, ordinary water (say 50 to 55 deg.) in the next, and, if desired to cool very low, *brine* in the last length which

should then be made of copper, though, for that matter, it is about time that *all coolers* were made of copper.

In the matter of cooling for *practical buttermaking,* I am decidedly opposed to the bacteriologists, who from a (justifiable) scientific standpoint, insist on cooling in a closed vessel like the "Russell" or "Potts" pasteurizer.

I have seen too great improvement in the cream after this combined cooling and aeration to give it up, and must insist on recommending either of the above-mentioned or similar coolers. It goes without saying that the room must be clean and the air pure where they are used.

The effectiveness of coolers may be reduced by sediment left by the cooling water and hence they should be cleaned inside now and then.

THE BODY OF PASTEURIZED BUTTER.

It used to be deemed a necessity to chill the pasteurized cream first and then reheat it for ripening, but I have found equally good results by simply cooling to ripening temperature (70 to 75 deg.) and then adding the starter, as long as this is done quickly.

But when ripe, or nearly so, it is absolutely necessary to chill it and keep it for at least a couple of hours at a temperature between 44 and 48 deg., or better still to cool it to about 46 deg. and leave it over night. If this is done the *body of pasteurized butter will be fully equal to the unpasteurized from the same cream.* Indeed, in some experiments made in Kansas it scored a little higher, and the trouble of the makers who have not got good body has been that they did not understand this or else did not have the needed conrol of the temperature.

WHAT TEMPERATURE TO USE IN HEATING.

Personally I have never tried to heat to more than 155 or 165 deg., and once when I had 170 deg. I got a cooked flavor in the butter, which, however, disappeared a week later. But that was in experimenting with hauling hot cream; it had been allowed to cool partially (to 138 to 140 deg.) in the jacketed cans from 2 to 3 hours, while skimming and hauling it the 13 miles to the central creamery where it was cooled at once.

Recent reports of Danish experiments convince me that the higher temperature cannot have been the cause.

At first the Danish creameries, 90 per cent. of which pasteurize; kept within the limit of 170 deg., but, in order to check tuberculosis, a law was enacted that all skim milk and buttermilk not used for cheese, should be pasteurized and the temperature of 185 deg. (later only 180) was deemed necessary for the continuous heaters.

Before passing the law experiments were made by the government expert with heating the cream (out of the same lot) to 167 and 185 deg. Out of nineteen cases, the judges found the butter from the cream heated to 185 deg. better in eleven, equal in six, and poorer in three, and though the variation was but small, the high heat showed the best keeping quality.

Other tests were made comparing 167 with 190 deg. Here 9 were better, 4 equal and 6 poorer from the high temperature, but in the second judging 11 were better, 6 were equal and 2 poorer. The cooked flavor was observable at first, but disappeared in a few days, but great stress is laid upon *quick* cooling. It may here be in order to sound a warning note as to the keeping of utensils clean when pasteurizing. If it is not done and if a film of casein is allowed to form, not only is the efficacy of the apparatus reduced, but a distinct unclean taste is imparted to the butter. The fact that this film is daily pasteurized does not help, nor indeed must pasteurization be deemed a panacea for dirty, tainted milk.

Do I advise pasteurizing for our creamery butter? For export, YES, most emphatically; for home trade, No, not if it is to be sold at once; the extra expense and trouble and the slightly reduced yield (which may be estimated to increase the cost of making from ½ to 1 cent per pound) does not pay in a market that does not seem to appreciate the value of *uniformity* to that extent.

But if it is to be kept in cold storage or if we look to the future general good of the American Dairy Industry I have to say yes here also, and hope for its general introduction.

CHAPTER XI.

RETURNING THE SKIM MILK.

SKIM MILK WEIGHER.

Various devices, all more or less complicated, have been patented by which the patron receives a check at the weigh can and this allows him to take his share only of the skim milk. Several worked quite satisfactorily, but have been given up as too complicated and none have, as yet, stood the test of years of experience. I should prefer to hire a boy, a girl or an old man to stand by a weigh can and scale. No doubt the problem will be, even if it is not already, solved in some way, and the just division of the skim milk provided, as this question causes more friction than anything else. It must be left to each creamery whether to keep a patent check weigher in order and clean or hire somebody to weigh the milk. *The skim milk tank and weigher should be cleaned every day as carefully as the receiving vat.*

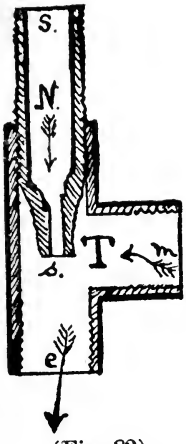
HEATING THE SKIMMILK.

In Europe the skim milk is heated in the more expensive apparatus described elsewhere, but the comparatively few creameries in the states, where the skim milk is heated, use steam direct from the boiler or exhaust.

A simple device for the latter is to place a can in the skim milk vat and let the skim milk be pumped into the can and overflow while the exhaust steam heats it in the can. Various other more or less complicated devices are used.

Heating this way cannot be recommended. Even with direct steam there is a dilution of about seven per cent., and with exhaust there must be more. It is time that creamery owners and patrons realized the full value of skim milk, and took proper care of it.

In heating a vat of milk or water with direct steam, the noise may be reduced and a current created by applying the

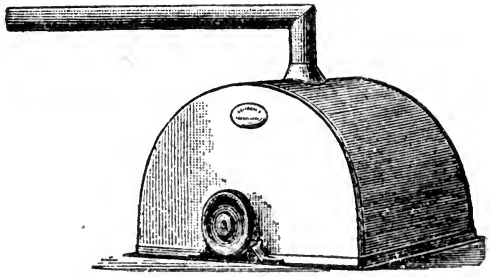


(Fig. 82)

steam as shown in Fig. 82. Have the blacksmith close up one end of a short nipple (N), so as to leave only a small opening (s), insert this in a common T and apply steam at (S); this will suck the milk or water from (m), and force it out at (e), creating a lively current in the vat.

But whatever heaters are used, those continuous heaters general in Europe or the direct steam, experience has taught us that the milk is liable to foam, overflowing the tank and preventing the filling of the cans in a satisfactory manner.

The simplest device to overcome this trouble, recommended by Prof. B. Boeggild, of Denmark, is that patented by C. Mikkelsen. The skim milk vat is made of heavy tinned steel plates with angle iron, round the top edge. This allows the clamping of the cover firmly and tightly. In the cover is an opening into which fits the half cylinder (Fig. 83) which is provided with two dashers revolving on a shaft driven with a cord pulley. The skim milk enters the vat through a closed pipe and the foam rises against the cover, where it is caught by the dashers and thrown against the cylinder, thus releasing the air which escapes through the ventilating pipe. This foam killer is not needed when the latest Fjord style pasteurizer (see Fig. 77) is used. In 1908 a Danish foam killing pump was introduced but has not been tried enough to obtain a reliable verdict.



(Fig. 83)

To secure full protection against tuberculosis, the milk should be heated to at least 180 deg. This is now compulsory in the Danish creameries. A test has been invented by Dr. Storch, by which the authorities can quickly and easily determine whether this has been done. The residue in the separator must also be burned.

CHAPTER XII.

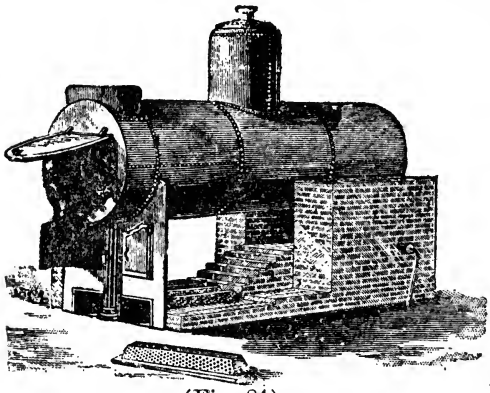
RUNNING BOILERS, ENGINES AND SEPARATORS.

Most of our dairy schools, dairy papers and books are all very weak on these points. The best book I know of is Prof. Michel's *"Creamery Buttermaking"* (see book list). There are handbooks on engines and boilers, but none popular enough written with special reference to creameries.

I do not feel competent to fill this want. It would take a 300-page book to treat the subject exhaustively, so here are just a few hints.

BOILERS.

Always have the boiler of nearly double the capacity of the engine and do not grudge at a few dollars extra, but get the best.

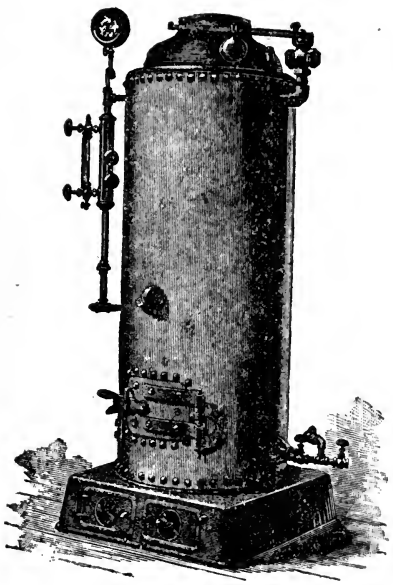


(Fig. 84)

For creameries the old standby, "the built-in tubular," like Fig. 84, is the best. If the smoke stack is built in front the top should be insulated, but if it is desired to have the smokestack at the other end, it costs but little more to lead the smoke back over the top, and this will act as an effective covering. In small skim stations and dairies the tubular upright (Fig. 85) is the one to choose, though it is much more difficult to keep clean.

Never buy a second-hand boiler without having it examined by an expert.

Before starting a boiler examine the safety valve and steam gauge (which should be at zero when the water is cold), the try cocks and the glass gauge.



(Fig. 85)

Never pump cold water into a hot boiler or blow it off under pressure. If the water should be low (which it never ought to be) find out if it is below the flues, and then bank or cover the fire with ashes or fresh coal if no ashes are at hand, or draw at once. Don't touch safety or any other valves, and under no circumstance turn on the feed until the boiler is partly cooled.

The water having been analyzed, consult an expert as to boiler compound, but potatoes or rice will, as a rule, be good enough, and not hurt the boiler as many compounds do.

To keep it clean let out about 2 inches of water every morning before starting the fire and wash out at least once a month. If flues gather scale scrape off. It is said that 1-16 inch loses 15 per cent. and ⅛ inch 60 per cent. of the fuel value.

Leaks should be stopped at once to prevent corrosion even so leaking valves where the drip hits the boiler. As soon as blisters appear, examine carefully and have them patched or trimmed. All parts of the boiler exposed to the fire should be kept perfectly clean and flues well swept, especially where wood or soft coal is used.

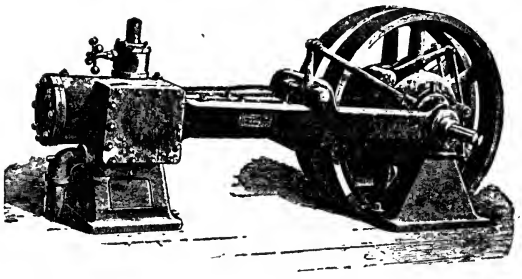
Mr. Krebs says in the "Dairy Messenger:" "In firing with fine coal a thickness of three or four inches is ample; when greater the combustion is imperfect, wasting fuel and preventing the full power of the boiler from being developed. A thin fire, sparing and frequently renewed, is attended in every way by the best results. The fuel should be heaviest at the sides, they having a greater supply of air, on account of the spaces unavoidably left between the fuel and the walls. Do not fire with large lumps. Boilers are often injured by unequal expansion and contraction, caused by a strong fire on one side while there is a draft of cold air through an open door on the other.

"If your boiler steams too fast, close your dampers and shut off the draft. Never throw open your fire doors when it can be avoided nor keep them open longer than is absolutely necessary. It is injurious to the boiler and wasteful of fuel."

(It is a good plan to arrange the grate door so that when it is open the damper is partly closed.)

"For boiler feed a small power pump, driven by a belt from the shafting is the best. It consumes less steam than a direct-acting steam pump, is cheaper and more reliable. It should be fitted so that it can be worked by hand also.

"Injectors and inspirators are frequently used for feeding boilers. They have the advantage that they are cheap, and that they impart some heat to cold water where this is used for feed. They cannot handle warm water and sometimes get out of order and will not feed, and as this is often caused by slight derangements of parts which it takes an expert to readjust, they often cause trouble. I for my part have had more trouble with half a dozen inspirators and injectors than with dozens of feed pumps, and have a positive ill-feeling against them. If you want to hear about their virtues you had better go to some agent for these goods; they will tell you a different story. It is nevertheless a handy instrument but a little tricky, and it is always wise to have a pump in reserve should the injector prove balky.



(Fig. 86)

"The water used for the boiler should be clear, pure and soft, as free from lime, magnesia or other foreign matter as possible. If it is taken from a stream that is apt to be muddy, make a little basin large enough to give the water a chance to settle. It will save its cost over and over again. Be most careful not to allow any swill or sour drainage to mix with the water you use. It will pit the iron and eat out the tubes in a short time. This is also sometimes the case with water from other sources, such as drainage from mines and even from apparently perfect springs."

It is also economy to have the engine at least 25 per cent. larger than actually needed. In choosing, simplicity, durability and steadiness should be considered, and a good governor is very important. Again I quote Mr. Krebs, who recommends one made by the Straight Line Engine Co., Syracuse, N. Y., (Fig. 86):

"The piston in an engine should be an easy fit, so as to move with little friction, and at the same time it should be steam tight.

"If the back cylinder cover is removed, little steam should escape if you place the engine on the front center, at which point the valve ought to admit steam to that end. Again place the engine on three-fourth stroke and turn on steam; here the slide valve ought to close both ports, and if the valve is tight no steam will escape into the cylinder or from the exhaust pipe. Should steam escape in quantities your engine needs repairs, in which case you will have to get a trained mechanic to face and bed your slide valve or refit the piston, as untrained people generally make bad worse.

"The escape of steam in the positions mentioned might also be caused by the eccentric working loose or having shifted. The angle of advance of the eccentric for ordinary slide valves should be such as to open the steam-port when the piston is at the end of the stroke, and the length of the valve-rod should be adjusted to give the valve equal opening at both ends."

Oil sufficiently, but do not slop it on the floor. Wipe the engine when stopping for the day and keep it bright and clean. Take a pride in it!

Before starting see that the governor is in good order, the belt not too tight nor too slack, that the engine is level and firmly bolted and that all boxes and shafting as well as pins and screws are snug and tight, that the exhaust is open and the crank not on the dead center and turn on steam slowly. Watch bearings closely in the beginning, and if a hot-box should develop and plenty of oil does not relieve it, stop and loosen it a little and try to finish your work. You may have to stop long enough to cool and polish before starting. If there is a grease cup on the crank and it is kept filled, it will seldom heat. A little plumbago added to the oil is also claimed to be a good thing for a hot-box.

Knocking or hammering may also be due to the piston touching the heads, to the fly-wheel being loose, to loose keys or slack nuts. Worn bearings may be filed on the edges so as to fit.

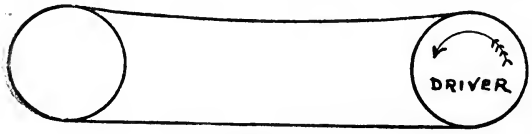
Always look over belts and everything in the afternoon, so as to be ready for the morning work. A leaky valve or union left to drip day after day is a "dead give away" of the maker as a careless one. Here as elsewhere, "a stitch in time saves nine."

Belts should be wide enough and long enough and pulleys large enough to allow them to pull without being too tight. They never work as well in a vertical as in a slanting, or better still, horizontal position. The lower side should be the pulling one. (See Fig. 87). If they slip apply a little belt grease (not too much), and keep them soft with a coat of it now and then. Only in emergency should powdered rosin be used. Protect leather belts againts moisture; if that is impossible use rubber.

A common fault in creameries is too light shafting. It is poor economy.

RUNNING THE SEPARATOR.

The separator, running at the high speed it does, is a delicate piece of machinery and requires more care than is usually given to it, which often does not exceed that given a chaff-cutter or threshing machine. For the hand separators, some of the following pointers for running power separators hold good.



(Fig. 87)

See that your separator is level and *follow the directions of the manufacturers closely.* Before starting be sure that they are put together right, that in the "Alpha" the riglet plates are in the right order in the right bowl and the right bowl in the right frame.

Watch all parts liable to wear such as the bearings and the rubber, which should be renewed whenever it loses its elasticity. The threads in the bolts in the plate that holds down the rubber ring should be watched as the loosening of this plate may cause an accident. In putting a new rubber ring in the upper bearing a little of it may be squeezed under the plate and this may cause the loosening of the screws.

See that all oil cups are filled with the very best oil and in good working order.

Don't forget to fill the bowl with water and to start slowly. Mr. Leighton, in the "Chicago Dairy Produce," from which some

of these pointers are taken, says that not less than five minutes should be used, and that when several separators are to be started he prefers to put on all the belts and start the engine slowly.

While the ear may be a guide to a musical buttermaker in guessing within a thousand or so revolutions per minute, never neglect to use the speed indicator now and then.

If there is a stoppage in the milk supply, drive the last cream off with skim milk or water, and if it is going to last half an hour or so—stop. If only for a short time, keep up the speed and let a small stream of water run through.

Mr. L. also thinks that about 10 drops of oil per minute should be enough and that if it takes 30 to 40 drops, it is time to send the separator to the repair shop.

Sometimes the machine does not skim clean, and milk is found in the frame. (I have seen the latter, or rather smelt it stinking). Try the bowl with water without the cover on and hold a dry piece of paper in front of it and you will soon know if the bowl leaks, but it is by far more common that the bowl is not set right, and hence a slight turn on the set screw below the lower spindle will raise or lower it.

At other times the supply is too small and consequently a richer cream is made, but more fat is left in the skim milk. Each machine should be run up to its capacity, and this should not be left to guess work.

Have two cans and let some one push them under the spouts, when you give the word with watch in hand, and pull them out after 1 or 2 minutes and weigh the cream and milk, then you *know* what you are doing. Mr. Baer tells me that more operators lose fat by running too little milk than any other cause.

TREMBLING MEANS LOSS OF BUTTERFAT.

As soon as the machine trembles, most operators think the bowl is out of balance, whereas in most cases it is caused by the bearings being worn and there can be no doubt that hundreds of creamery owners or managers incur heavy repair bills by not renewing the worn out bearings in time. Duplicates should be kept even if the outlay appears heavy at first.

Carelessness in handling the bowl, especially in washing, will often bend the spindle a trifle, and then the bearings will wear double quick. In hand separators curiosity often leads the owner to unscrew the spindle covering. In replacing it they do

not get it to fit right and when screwing the cover on bend the spindle against the cog wheel.

But there is no end to the ways in which the operators get into trouble; most of them can be avoided by following directions of the manufacturers strictly. and not touching screws one has no business with. When in trouble write directly to the manufacturers describing carefully all the symptoms.

Don't be tempted to *buy a cheap oil* "just as good," buy the very best you can get.

CHAPTER XIII.

ORGANIZING CREAMERIES.

CO-OPERATIVE.

The co-operative creameries are the best wherever the members have learned to co-operate in the true sense of the word, have found the right man to manage, and trust him. The lack of these essentials is the cause of their downfall in, alas, too many cases.

But even at their best, a single co-operative just as a single individual creamery, will find it hard to compete with the large creamery companies which run from ten to one hundred creameries and have systematized the work of producing uniform butter at one end and seeking a market for it at the other. These creameries are in reality an extension of co-operation, and have relation to the single creamery similar to the latter's relation to the private dairy.

Nevertheless I believe in the ultimate success of the co-operative system, though it may require modification of our present laws to allow it to embrace the combination of several co-operative creameries under one management. Or the Canadian syndicate instructor system may be adopted.

As soon as it is found that the owners of at least 400 cows (within a distance of four to five miles of the intended creamery site) have agreed to join and deliver the milk, they should organize, and, while listening to what creamery promoters may have to say, make independent investigations.

As a rule they will be able to get good advice from the Agricultural College of their own state, and it is a good plan to send a committee of investigation to some successful co-operative

creamery, but *never* should they accept the invitation to do so at the expense of a smooth-talking agent.

The preliminary expenses should be subscribed in cash by the would-be members, but, as a rule, the needed capital can be obtained from the local banker, securing it by joint notes or by the directors' individual notes and payable from a fund created by retaining a certain amount, generally five cents per 100 lbs. of milk, out of the dividend.

Suggestion for constitution and by-laws may be found in Profs. Farrington and Woll's book on *Milk Testing*, but it may be wise to consult a lawyer so as to be sure of the state laws. I shall only give the hint that unless the directors leave most of the details in management to the secretary or manager, it is by far the best not to have too many directors.

In rendering account to the patrons of any creamery it seems to me that the only right way is to give all possible information, say something like this:

STATEMENT FOR THE MONTH OF ——, 1910.

Total milk received, ——— lbs.; butterfat, ... lbs.; butter made, ——— lbs.; ———————(Name); delivered, ——— lbs. of milk; testing, ——— per cent, or ——— lbs. butterfat at ——— cents per lb., $———.

INDIVIDUAL CREAMERIES.

If co-operation is not desired to the extent of building and running the creamery, it is an easy matter to induce some individual or company to build one, provided you can agree to deliver the milk from 300 or 400 cows. In that case subscribe the cows and a cent or two per cow to pay for advertising in the dairy papers, and you will soon have propositions enough for a creamery. The milk should be paid according to test and the price fixed according to some market—New York or Elgin. The cost of making will vary from 2½ to 4 cents, according to amount of milk delivered.

COMBINATION SYSTEM.

The trouble with the individual creamery is that no one can afford to put up a good brick building with cement floor, etc.,

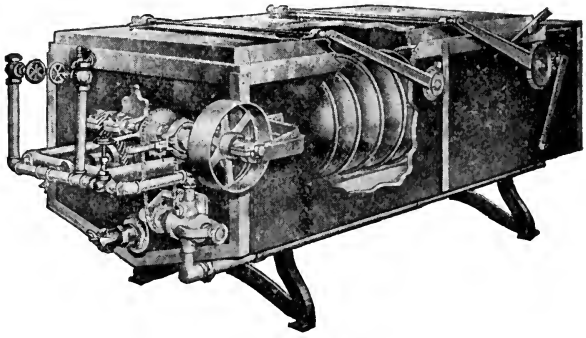
and take the risk of patrons leaving. For this reason I am in favor of the farmers always putting up at least the building and then letting it with or without machinery, if they don't want to run it themselves. The rent should depend on price paid for the milk and according to the quantity of milk delivered and be free if the average is less than 3,000 lbs.

A similar system obtained in Kansas and Nebraska, where large companies built and equipped large central creameries, and then offered to put up skim stations all around for a certain sum. The farmers agreed to sell their cream and pay for the skim station in that way, and if, after a certain time, they did not want to sell cream any more, they owned the building and might change it to a creamery.

This system has, in the past six years, to a great extent, been superseded by the readoption of the gathered cream system in a modified form.

GATHERED CREAM CREAMERIES.

The most extensive creamery system used before the advent of separators was the gathered cream system, where a "churn station" was erected and teams sent out in all directions to gather up the cream raised by shallow or by deep-setting under all kinds of conditions.



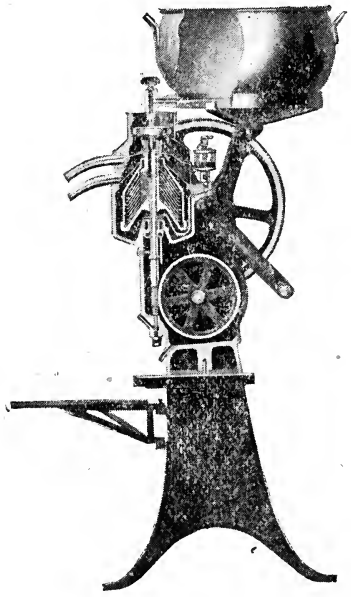
(Fig. 88)

Only in exceptional cases was the cream paid for according to grade, and the result was anything but satisfactory. The creamery owners were, as a rule, satisfied as long as they got their

margin of profit per pound and had but little interest in quality as long as they could get quantity.

With the advent of the separator these were pushed too far into the gathered cream creamery districts, and milk was hauled from 10 to 20 miles.

A reaction had to come and did come with a vengeance. The sale of hand separators was pushed not only where they legimately belong, but also where creameries and skim-stations were doing good work. Separator agents, in their anxiety to sell, claimed there was no need of cleaning the hand separators every time they were used, and the result has been a deterioration of the average quality of the butter made in the former whole milk creamery districts.



(Fig. 89)

Now I am willing to grant that *if* the hand separators are kept clean, *if* the cream is properly cooled, and *if* it is delivered as often as the milk is, *then* just as good butter can be made, but there are too many *ifs* in the proposition, and the system has to be run on a large scale involving long railroad shipments if the full economical benefit of centralization is to be obtained, and this fact has evolved a new system.

THE CENTRALIZED CREAMERIES.

This book is not written for centralizers and I shall only refer to the troubles and dangers of the system.

First of all, it is a system which requires a special freight rate from the railroads and as such is dependent on these when once an expensive plant has been established.

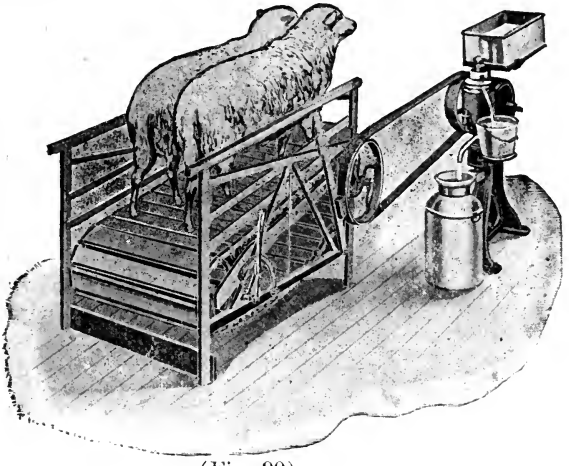
Secondly, there is a limit to the profitable concentration of all manufacturing plants, even those of steel, and how much more those of butter.

The strongest point claimed in its favor is "uniformity," but with from six to twenty-four or more different daily churnings

and with the absence of uniformity in the cream received, this advantage is, to a great extent, imaginary.

Educational work among patrons is virtually made impossible unless indeed an enormous staff of expert cream agents are appointed, in which case the saving cost of manufacturing will disappear.

My own belief has always been and is now that the only permanently successful way in which the centralizing system can be run, is by having cream gathering stations at the shipping points provided with pasteurizing apparatus (heaters and *coolers*) in charge of specially trained men who gather the cream every day in summer and every other day in winter, in the forenoon, and pasteurize it before shipping.



(Fig. 90)

Meanwhile these factories are doing the best they can, and try to improve the quality by pasteurizing at the central plant and aerating while hot—virtually a renovating process for the cream—and using a large per cent. of starter to a very rich cream.

Special vats have been designed like the Wizard Agitator made by the Creamery Package Mfg. Co. (Fig. 88), in which the cream may be quickly tempered and mixed. It consists of an insulated vat with a hollow rotating screw agitating and tempering device and mechanism for operating same. The vat is supplied with a cover consisting of several thicknesses of metal separated by insulating material. This cover, when closed, is sealed with a water seal. It is attached to the vat by means of two sets of parallel arms pivoted to the cover and journalled on the sides of the vat. A crank is used for raising and lowering the cover. When open, the cover is overhead and allows free access to the vat from all sides. The screw, extending from end to end of the vat, is built around, and fastened to a hollow steel shaft extending

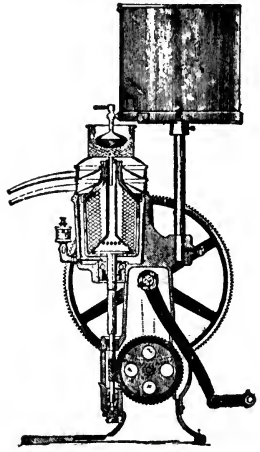
(Fig. 91)

through the ends of the vat, rotated by means of a bevel gear, shaft and pulley. Through this screw the tempering water—hot or cold—circulates. These vats are now also used in larger local creameries.

Indeed I may fairly say that the managers of these plants are doing all they can to make the best possible butter, and we must look to the cream producers for further improvement in the quality.

I understand that payment by grade is now used at some factories, but fear competition among the different centralizers will make this plan as impractical as with the old gathered cream system and that to get their profit on as many pounds as possible, the operators will not be able to carry out the grading properly.

There are now, I presume, over a hundred different hand separators in the market, and the same rule holds good as to selecting one as for the power separators. I illustrate some of the leading ones in the Alpha, Fig. 89; the U. S. in Fig. 90; the Simplex in Fig. 91, and the Reid in Fig. 92.



(Fig. 92)

Unless they are kept clean and are run at the proper speed, the advantage of centrifugal creaming is lost, and if great care is not taken the cost of repairs is likely to be large.

I cannot recommend the hand separator system be it with local factories or centralizing plants, wherever 10,000 lbs. of milk per day may be secured within a radius of 3 or 4 miles.

CHAPTER XIV.

CREAMERY BUILDINGS.

SITE AND SURROUNDINGS.

In making a choice as to location, having made sure of the cows, the following points should be considered: (1.) A supply of good water. (2.) Possibility of proper drainage. (3.) Absence of disagreeable odors. (4.) Central location (central as to milk supply, not geographically), preferably at a junction of roads. (5.) Nearness to railroad station and ice supply.

A good substantial macadamized driveway and yard should slope from the building. If a dug well is to be used the greatest care should be taken in preventing surface water and drainage from getting into it; the only safe supply is an artesian well.

Too often the location is made a matter of compromise between patrons who try to get it near their own farms instead of finding the best place for the creamery.

THE BUILDING.

The *foundation* should be made of stone and started below the frostline. The floor should either be good smooth flagstones or hard, glazed bricks, both laid in cement, or a good concrete foundation for a Portland cement floor. A poor cement floor is a delusion and a snare. Wooden floors should be made of 2-in. Georgia pine, either beveled and corked like a ship's deck, or matched and leaded. Soak with hot linseed (boiled) oil before putting in use. The walls of the best modern creameries are made of brick, preferably hollow brick, but in any case with 1-2-inch air space in the center. The inside walls should be finished with cement plaster or some of the patent waterproof plasters. If of wood, I prefer inside lining of oiled Georgia pine up and down without any bead and at least two air spaces lined with good paper.

The windows should, as much as possible, be on the north side and provided with screens, Venetian blinds, and in the north, at least, with storm sashes.

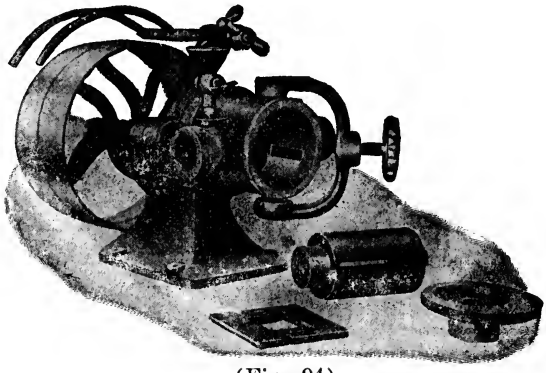
The roof should have a steep pitch and is best made of slate, but shingles boiled in a copperas solution will do. Tin roofs are

all right for the boiler room, but too warm for the creamery proper and, if used, should be painted white. The ceilings should be double with air space. The smoke stack should be made of brick and rather be 10 feet too high than, as they generally are, 20 feet too low.

As to construction for small creameries where one man has to attend to boiler and engine, separators or churns, as well as to receive the milk, the one level system is the best.

The churn floor should be lowered enough to run the cream from the vats into the churn.

Unless one has a self-lifting heater or elevator, a pump must be used, and if so, one like the "Ideal" (Fig. 94), the one invented by Mr. Wilmann (Fig. 95), or the Jensen sanitary pump (Fig.



(Fig. 94)

96), made of tinned bronze and fitted with union connections for sanitary pipes, which are all easy to clean. Finally I must refer to the latest Swedish which is like the old rotary force pump with cogwheels but has a loose plate (imbedded in the removable side cover) which may be set, while running, at various distances from the cogwheels and thereby regulate its capacity from 500 to 5,000 lbs. per hour.

But pumps—even the most sanitary—are dangerous in a creamery and hence, where the location allows and the creamery is large enough to allow the use of a special milk receiver, I prefer the drop system which allows the milk to run from the weigh can to the receiving vat, then to the heater, separator and cream vat (via the pasteurizer if used) and thence to the churn.

The objection to the extra steps up and down necessitated by this system should have but little weight compared with the

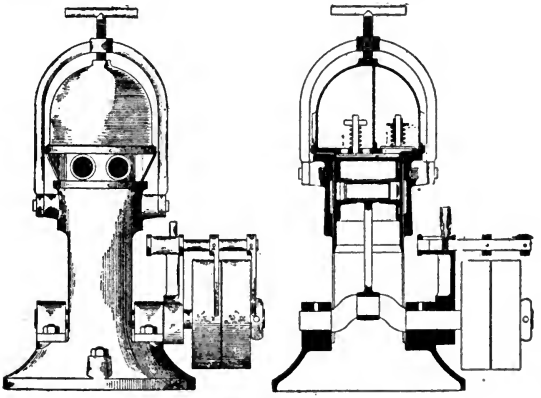
advantage of doing away with pumps, but most of the steps may be done away with if an elevator, as suggested by me on page 49 or—better still—the modern Danish hydraulic one, is used.

The Danes tried, years ago, a cream elevator with cans moving automatically up and down on an endless chain emptying themselves into the cream vat above, and though they seemed to work well and they were used in many creameries they never became general and are now hardly used, and the hydraulic elevator (see Fig. 35, page 49) is now being introduced.

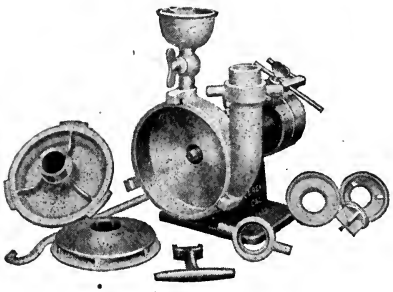
But even if we manage to do away with pumps altogether there still remain the fixings and pipes which should be perfectly smooth and tinned inside with curved copper bends instead of the common L and only short pieces of pipes coupled together whenever open conductors cannot be used. I am pleased to find that the manufacturers are at last pushing such "sanitary" (more or less) fittings and cannot too strongly urge buttermakers and managers (or owners) to insist on getting them irrespective of the extra cost. Poor fittings remain yet the weak point in most creameries and in the city milk depots.

Finally I want to draw attention to the 1909 novelty—the Jensen can drier (Fig. 97) which—if dust free air is used—seems to me of value in all creameries where the milk or cream cans are returned cleaned and empty.

It would be absurd to prescribe any special creamery plan; if the buttermaker is engaged it is well to consult him, but certain general rules should be observed, such as having the ice house (if any), refrigerator, churn, work room and cream room away from the boiler and engine room in the order named, the ice house being the farthest north. The engine should be in the separator room, not in the boiler room. Also to have the coal room next to boiler and easily accessible to unload



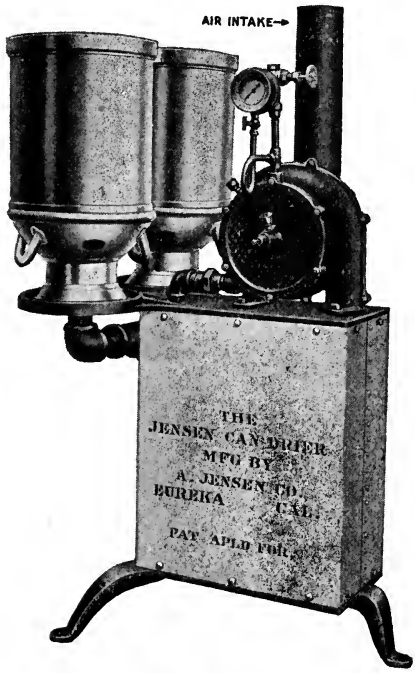
(Fig. 95)



(Fig. 96)

the wagons. To have the skimmilk tank where it can be got at for cleaning and where milk spilt in drawing will be drained and not soak into the ground and make a stench. To have all floors slant to the gutter and the drains provided with traps, and to have good ventilation.

The creamery industry is no longer an experiment. Prosperity has followed in its footsteps, and land values have increased when it has been conducted rightly. Hence, the creamery should be looked upon as a public institution, like a court house, postoffice or school, and be built neatly, solidly and permanently, even at a greater expense. On the front cover is shown the facade of a Danish co-operative creamery. I am glad to note that during the last fifteen years similar substantial creameries have been built in the West. May the good work go on. In many cases bricks will only increase the cost slightly, and though it may sound harsh, I must say that it would be a blessing if five out of ten creameries burned down, provided proper brick buildings were substituted.



(Fig. 97).

Various plans may be found in the catalogues of dairy supply houses, and when you order an outfit they will, as a rule, give advice and often modified plans free, but it is safer always to get the advice of a government expert or pay for that of a private disinterested one.

CHAPTER XV.

DAIRY EDUCATION.

No creamery buttermaker should be satisfied, even if he has ten years' experience in a creamery, until he has taken a creamery course in a dairy school. The greater his previous experience is, the more he will learn, and he must have at least one year's experience to get any good from the course at all. Indeed, most schools now demand this.

Granting even that he may be a better maker than the teacher, that he is a smarter mechanic, that he knows more about running engines, separators and machinery generally, the fact remains that he will leave the school with a new view of his work, with a greater pride in his profession, and with a clearer eye to possible self-improvements. As for finishing his education, the very best makers are those who do not finish until their life's churning is done.

As to the dairy course, any farmer's boy or girl can get great good out of a short course, and no one who can possibly afford it, should neglect to take one. After all, however, it is but a small minority of the farmer's boys and girls that can get to these schools, and though we have, in the Farmers' Institutes and various conventions, the means of bringing dairy education nearer to the farmers, I hope yet to see the modified "Belgium" system, (urged by me for years in vain), adopted. By this system, any county or township that agrees to provide room, ice and milk, and where at least 10 students enroll, should secure a month's dairy schooling near home with a minimum of science and a maximum of practical suggestions how to do the best work under the present condition.

I consider the one week's instruction given by the English and Canadian traveling schools too short, and the same money spent on the plan I urge will reach more people and do more good than ten times the amount spent on the large central dairy schools.

The latter we must have—and they should be the Dairy *Col-*

leges or Universities, if you please—but we have now enough of that kind such as Wisconsin, Iowa, Minnesota, Ohio, New York, etc., to educate the needed creamery butter makers, whose salaries are too low as it is. What we need is to help the private dairymen and the *milk producers,* and these can best be reached by the proposed perambulating Dairy *Grammar* School. Or, better still, perhaps the time will come when the whole system of education will be modified; when the county "grammar" school will be cut down to four or at most six years, when text books pointing *to* the farm instead of *from* the farm will be used; and when county farm and technical schools will take the place of the last two years of our present grammar schools, and the first two years of the regular high schools, leading, as the case may be, to the state agricultural, the technical or classical university.

The Dairy Press is an important link in dairy education, and no dairyman should be without several, first of all *"Hoard's Dairyman,"* and creamerymen should have *"New York Produce Review,"* the *"Dairy Record," "Creamery Journal," "Chicago Dairy Produce,"* etc. A full list of dairy papers is given elsewhere and any of them will cheerfully send a sample copy.

The Dairy Division, U. S. Department of Agriculture, Washington, D. C., may at any time be applied to for advice, and help and will send such bulletins as may assist you in your work free of charge or at a nominal cost.

But of all the means of patrons' education, I rank as highest the school house meetings, held once a month or so, where neighbors may meet and exchange views. Such a "club" should own a library for reference, and I suggest as a *"starter"* Prof. Henry's *"Feeds and Feeding,"* Prof. Russell's *"Dairy Bacteriology,"* Prof. Farrington and Woll's *"Testing of Milk and Its Products,"* Prof. King's *"Physics of Agriculture,"* which means an expenditure of only $5.75, or a complete farmers' library (co-operative) might be established at the creamery, see book list.

CHAPTER XVI.

VARIOUS KINDS OF BUTTER.

The various designations used on the markets for butter are as follows:

CREAMERY "specials," "extras," "firsts," "seconds," "thirds" and (seldom) "fourths."

DAIRY "extras," "firsts" and "seconds."

IMITATION CREAMERY, RENOVATED OR PROCESS, LADLES OR FACTORY, PACKING STOCK and finally GREASE.

"ADULTERATED" butter, while defined officially, is not quoted on the market.

Butter is scored on a scale of 100 points, with 45 for flavor, 25 for body, 15 for color, 10 for salt and 5 for style.

CREAMERY.

As creamery butter is accepted all butter made either by the separator creamery system or gathered cream creamery. "Specials" must score 93 points or above from May to November, and 92 points during the other months. "Extras" 91 to 92 points, and 90 to 91 points; "firsts" 81 to 90 points and 86 to 89 points; "seconds," 82 to 86 points and 81 to 85 points; "thirds," 80 points and below. This basis of scoring is in use in New York. Other markets vary their standard slightly.

DAIRIES.

Dairy butter is that made on one farm and classified like the creamery.

IMITATION CREAMERY.

This is dairy butter delivered in granular or at least unsalted form, worked, salted and packed by dealer or shipper. There is hardly any of this on the market now, but the name is sometimes used for high grade ladles or factory butter.

RENOVATED BUTTER.

Renovated or Process butter is any kind of pure butter melted, and after the clear oil is separated and purified, it is rechurned with ripened cream or milk. The manufacturer has now to pay a license of $50.00; all tubs must be marked according to law and a tax of 1-4 cent per pound be paid.

LADLES OR FACTORY.

This is dairy butter, graded or mixed, reworked, colored and salted. The better grades are sometimes often fraudulently branded "creamery." The output of ladles has been greatly reduced since the introduction of the improved system of making up such butter as Process butter. In ladles all dirt is retained, while in process butter it is eliminated. There is now a great danger in ladling as the water content must be kept down to 16 per cent. or less, and if it exceeds that, prosecution for making "adulterated" butter may follow.

PACKING STOCK.

Packing Stock is dairy butter of all kinds, packed either each roll wrapped separately or promiscuously thrown into a box or barrel.

GREASE

Grease is any kind of butter unfit for human food.

ADULTERATED BUTTER.

As adulterated butter is classed butter, which, by any process of churning, ladling or renovating, is made to contain an abnormal amount of moisture or solids other than fat. Manufacturers have to pay $1,000 license and the product is taxen 10c. per pound.

I understand that several ladle creameries and dealers have been heavily fined by the internal revenue department for butter having more than 16 per cent. water, which has been declared the limit. It is therefore well for buttermakers, especially in the South during the hot weather, to be on their guard and not incorporate too much water in their butter.

Under this head comes the "black pepsin" or "butter rennet" frauds, but not adulteration with foreign fats which comes under the classification of oleomargarine.

WHEY BUTTER.

In making "Cheddar" cheese there ought to be but little fat left in the whey, and it is a doubtful question whether it would pay to separate it. Otherwise with "Gouda," "Edam" and "Swiss" there is left enough to make it worth while. The whey is left to "cream" by gravitation and churned the usual way and the butter is, as a rule, pretty poor, though I have sampled some very good in England. By running the whey through a separator, taking one-fifth as cream the first time and then running this

through a second time, a churnable cream may be obtained which will give a very fair butter if the original milk was good. If the whey has been heated to 130 or 140 degrees as in Swiss cheesemaking, it may be advisable to use a starter, otherwise the cream is ripe enough as a rule shortly after separating. Makers of whey butter must be careful not to incorporate more than 16 per cent. water.

The whey butter industry among the Canadian Cheddar cheese factories has gained quite a foothold during the past few years by separating the whey cream and sending to central churning stations.

DEVONSHIRE BUTTER.

The thick Devonshire cream before described is churned in a short time by stirring it by hand in a tub. This system obtains as yet to a certain extent in England.

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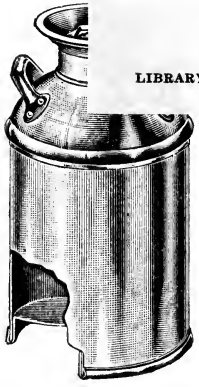

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